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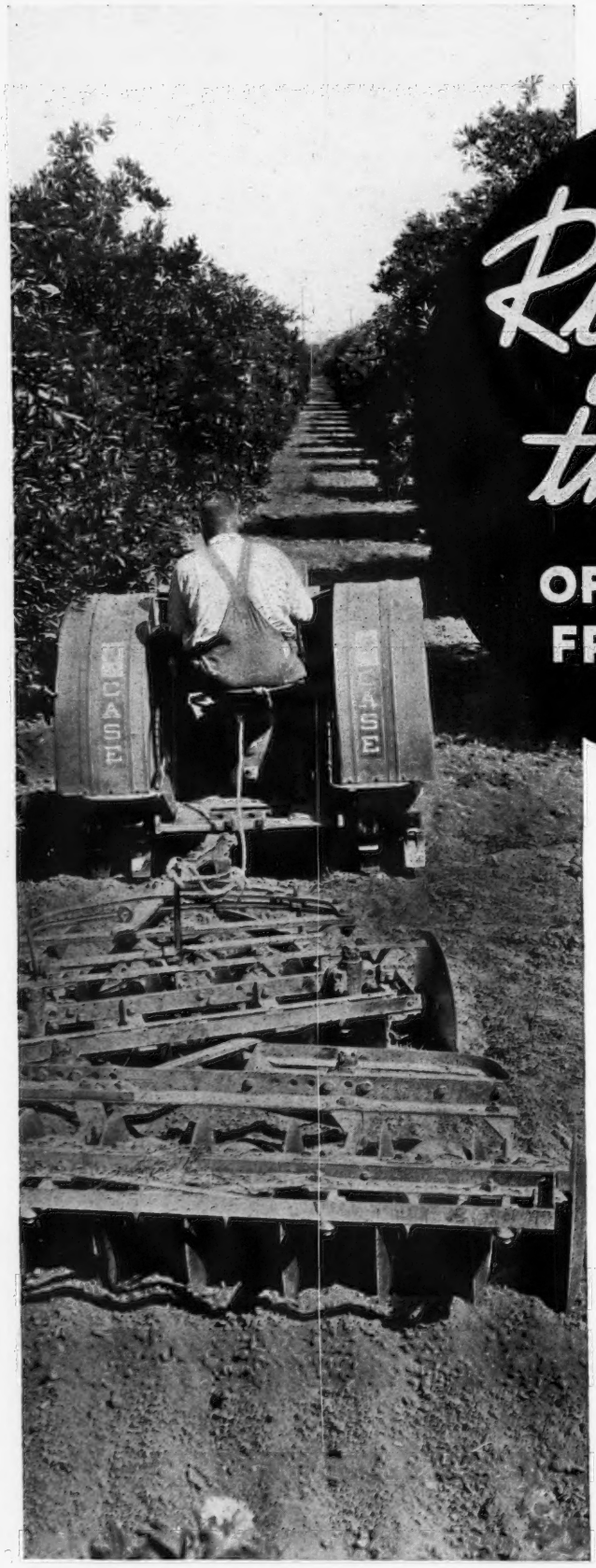

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From Production to Protection

AT ABOUT the time these pages are mailed to readers, the North Atlantic Section of the American Society of Agricultural Engineers will be meeting at the New York farm where, a hundred years ago, John Johnston laid the first tile land drains in America. They will be gathered to dedicate an appropriate memorial to John Johnston and his achievement. It has been said that civilizations may be measured by the manner and the degree in which they take pains to preserve and honor the memory of those who have lived and passed on. If this be true, then let it be said that engineers take their proper place as part of a civilized people.

Yet, in its timing, this tribute to the father of tile drainage is more than the mere rounding out of a century, which after all is only an accident, an arbitrary span arising from a system of numeration founded on the biological fact that mankind has ten fingers—or, in the interest of strict accuracy and evolutionary etymology, ten digits. This centennial, falling in the middle of America's first century of centennials, may well be chosen as marking the transition from the era of exploitation to the period of protection.

John Johnston was a pioneer—indeed a genius—in his phase of soil exploitation. His emphasis, and that of most agricultural progress up to now, was on production. Protection of soil as a permanent resource was but dimly sensed, much less understood. Even in fertilization there was no clear distinction between enhancement and stimulation; indeed it may be questioned whether that distinction is yet clear outside of academic circles, or enough heeded within them.

It seems symbolic that in 1935 falls both the memorializing of John Johnston and the emergence of the ASAE Land Reclamation Division as the Soil and Water Conservation Division. Johnston was the engineer of soak-in for immediate production; now we are in the first flush of engineering runoff for permanent productivity. May our work prove as surely sound as has that of Johnston!

New Promise by the Most Permanent Improvement

IN TILE DRAINAGE we have the paradox of something designed for immediate exploitation proving to be the most permanent of farm improvements. Though he was groping his way in an unexplored realm, John Johnston's tile drains still function. How few other so-called permanent improvements of that or any other time have suffered so little from decay or obsolescence!

In Illinois, for example, the tile lines that our grandfathers laid to tap the sloughs have permanently changed the face of the earth. Grandsons on the land today know not that the sloughs ever existed. They drive tractors where grandfather's oxen mired down. Alfalfa flourishes where only slough hay could grow. And in the rare cases when a tile line fails, present operators hardly know what is wrong, or where to look for it. Tile, where it was laid two generations ago, is no more of a conscious reality than climate.

Though primarily an engineer of soak-in, the record shows that John Johnston used his tile to some extent also for the orderly disposal of runoff. That remote precedent seems to deserve serious study in our present emphasis on erosion control by runoff engineering. To a large extent our terracing and related measures are being applied on soils and topography where underdrainage is not obviously needed. John Johnston showed that underdrainage of high ground was hardly less valuable than that of low land.

We may find tile lines laid below the channels of terraces to be a logical solution of the outlet problem in certain conditions. Terraces might be of reduced or even zero gradient. Increased capacity of underdrained soil to accept soak-in may, in some cases, sufficiently reduce runoff to modify the design of surface treatment necessary. The influence of deep drainage on the rooting habits of plants, and the ensuing effects on permeability and moisture-holding capacity, may have practical significance in relation to surface erosion.

Correlation of tile with terrace has implications beyond the boundaries of the individual farm. Tile as a metering device, as well as a non-eroding flow line, if backed up by temporary storage in level terraces and in the soil, may offer possibilities for stream stabilization and flood control. Certainly tile effluent carries far less silt than surface waters, and in some degree should reduce the sedimentation problem.

With modern methods for making tile, modern roads and vehicles for its transport, modern machinery for laying it, modern engineering to plan its installation, modern power, tools, and explosives for subsoil treatment to enhance its effectiveness, and modern rates of interest for its financing, there may well be a renaissance in tiling. The centennial of John Johnston may be not the burial of his work, but the planting of a second growth.

A Model of Orderly Research

ASIDE from its technical interest, the paper by G. A. Cumings appearing elsewhere in these pages deserves attention by and beyond our profession because it exemplifies vividly the need for and advantages of public research as contrasted with that by manufacturers or other private interests. It affords also a splendid illustration of what can be accomplished by correlation of numerous primary research agencies supplemented by cooperation from related industries.

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As the work in fertilizer placement has developed year

by year, it has become appallingly apparent that the major part of the problem is to find out where the fertilizer should be put. That fertilizers and machinery for their application have been used with reasonable profit for many years without anyone knowing just what the latter should do with the former is most amazing. To determine for every combination of soil, crop, and season throughout the many regions of this varied land the optimum placement of fertilizer is obviously too great a task and too serious a responsibility for any manufacturer, industry, or group of industries. After all, their job is to design, manufacture, and market efficiently certain closely defined classes of products, not to carry on research into the fundamentals of that other great industry, agriculture.

In its own province of invention and manufacture, the farm equipment industry has been prompt, efficient, and more. It made fairly serviceable fertilizer devices when no one knew what was needed. It has brought out new designs on the heels of nearly every step in discovery, combining low cost and simplicity in construction with uncanny precision in conforming to the job requirement laid down. It has done these things in the face of probabilities that further research would revise the desiderata and render their designs obsolete.

On the other hand, the scientists charged with job definition have stayed within that field. They have used special machines for experimental purposes but have not attempted to control the design of commercial machines. Here again is a textbook case for those who favor punctilious division of function between discovery of method and design of machinery.

Besides its value as a broad example, fertilizer technology merits sustained emphasis in its own right. There is abundant evidence that the traditional trinity of nitrogen, phosphorus, and potassium will be allied with a score or more of other elements, some of them rather rare and costly. As the use of fertilizer multiplies—and it must multiply far beyond the present average of less than one ton per farm—efficiency in its utilization must constantly increase.

Some elements, of which nitrogen is the familiar example, are largely lost if not promptly assimilated. Prompt and complete absorption would seem to be largely a function of placement. The old argument between feeding the soil and feeding the crop is doomed to disappear with better understanding of which elements are abiding, which transient; those which serve all crops, those of particularized value.

While the present emphasis in soil conservation is on its physical aspects, and properly so, the reclassification of land and the creation of adequate vegetative cover will inevitably require much chemical amendment of soils. Prompt germination and rapid early growth take on added significance as means to minimize the unprotected nudity of susceptible soils. In precisely these respects optimum placement will be demanded to achieve not only efficiency, but effectiveness, of fertilizers.

Permanence and Insurance

INTRODUCING his article on farm structures embodying the new, low-cost, precast joist construction, appearing in this issue, F. A. Lyman suggests that their earlier adoption in urban building practice was due to the urban locations of concrete products plants in which the joists were produced. This seems to lead logically to one or both of two conclusions: (1) Freight from precasting plant to farm is prohibitive; (2) architects, contractors, and building material dealers serving agriculture are asleep at the switch.

When, later on in the article, we read that this construction increased the total cost of a specific job by only about three per cent over that of combustible floors, it appears that, for the specific case at least, the freight cost is no insuperable item. The alternative conclusion is something distasteful to contemplate.

Searching for possible escape from this dilemma brings into scrutiny the matter of insurance premiums. In studying the sources of farm fires, and in advocating features of construction and methods of management to prevent fires and minimize fire losses, the underwriters have done a splendid job. Have their rate-making departments been similarly prompt and punctilious in reflecting hazard-differentials into insurance premiums? Have they shown engineering perspicacity in classifying and evaluating risks, or does the alleged law of averages create a sort of statistical fog?

When combustible and incombustible construction were so far apart in cost as to preclude the latter, except in rare cases, this may have been a moot matter. Such, it now appears, is no longer true. From the standpoint of clerical convenience, the percentage of fireproof or low-hazard farm structures may be, and for some time may continue to be, too small to justify complication of rate set-ups. As a matter of far-sighted policy it would seem worth some trouble to offer tangible encouragement to the construction of lower-risk farm buildings.

The farm structures engineer, in his capacity as confidential advisor to the American farmer, should have something to show besides the obvious fact that a concrete block, a steel sheet, or an asbestos shingle will not burn. He should be able to show by insurance rates a definitely favorable influence on the annual cost of carrying the building and its contents. The alternatives are (1) cheap construction to minimize the capital value on which insurance is paid and (2) encouraging owners of low-hazard structures to carry their own insurance. The latter will tend to leave the underwriters a remnant of fire-traps and add pointless force to the argument that farm fire insurance is unprofitable.

Recent and imminent adjustments in other elements of fixed cost throw insurance charges into sharper relief. In most states a rather substantial reduction in realty taxes has been effected. In some, the state tax has been abolished entirely. The relief so given is more marked for farm property because the state tax is or was a larger fraction of the total taxes than for urban property. Sooner or later the universal trend toward low interest rates must get around to farm investments and improvements. These reductions in annual cost, combined with such lower depreciation charges as more permanent construction may justify, make the future brighter for that type of building than for many years. Any better differential in insurance cost will still further brighten the picture.

Research Work in Cotton Ginning[1]

By Chas. A. Bennett[2]

ONE OF THE MOST important fields of activity in which the profession of agricultural engineering is vitally interested is that of cotton ginning, which brings to fruition a multitude of planting, cultivating, harvesting, and processing practices employed during the several stages of the cotton crop. Although it is generally realized that cotton ginning constitutes perhaps the most important of the preparatory steps in the marketing of raw cotton, nevertheless few people have any idea how complex the problems of ginning are, or how many different phases of agricultural engineering may be concerned in the efforts to obtain maximum quality in the ginned lint. There are intricate and involved difficulties in searching out the truth, because the different types and designs of ginning apparatus are forced to handle a material which may have almost an infinite variation in fibers, seeds, moisture content, and other physical characteristics, many of which may be significantly influenced by the engineering procedures adopted in planting, cultivating, and harvesting.

In a broad sense agricultural engineering research in cotton ginning, as in other subjects, is an orderly search for and assembly of facts by experimental, analytical, and other methods. Congress recognized that a well-planned and vigorous program in cotton ginning research would render a much-needed service; and to this end established in 1930 the U. S. Cotton Ginning and Fiber Investigations. These were placed under administration of the Secretary of Agriculture, who assigned the engineering responsibilities to the Bureau of Agricultural Engineering and the fiber-quality responsibilities to the Bureau of Agricultural Economics.

The ginning laboratory at Stoneville, Miss., was constructed by the agricultural engineers during the latter part of 1930, on a tract deeded to the United States by the State of Mississippi. The ginning laboratory building is a three-story structure of steel, hollow tile, and cement stucco, containing well-equipped shops and a wide variety of drying, cleaning, conditioning, and ginning apparatus. Adjacent to the ginning laboratory, in 1934, the engineers constructed a second three-story building for fiber laboratories. A cotton house and an all-steel storage building afford facilities for storing seed cotton not ginned immediately upon delivery and samples derived from the tests. Other structures such as sun drier, delinting house, artesian well, incinerator, and superintendent's dwelling have been provided.

The experimental machinery in the ginning laboratory comprises a wide variety of different commercial saw and roller gin stands, air-line cleaners, out-of-the-air cleaners, unit extractor-feeders, cleaning feeders, separators, driers, linter, condensers, press, and other auxiliary apparatus. These machines are equipped with motor-driven, variable-speed devices by means of which a broad variation in speeds may be immediately obtained. The fiber laboratory building houses length-array, color, moisture, microscopic, classing, and other laboratories fully equipped with apparatus for making tests on samples of seed cotton, ginned lint, and by-products. Several views of the ginning and fiber laboratories are shown in Fig. 1.

The personnel of the Bureau of Agricultural Engineering assigned to the ginning laboratory comprises the engineer in charge, two agricultural engineering assistants, and the necessary laboratory and clerical assistants, mechanics, and unskilled labor. The personnel of the Bureau of Agricultural Economics assigned to the fiber laboratories associated with the ginning studies comprises, at Stoneville and at Washington, the technologist in charge, five technological assistants, one classing specialist, and a number of laboratory and clerical assistants and unskilled laborers.

APPROACH TO COTTON GINNING PROBLEMS

The principal objective of the cotton ginning and fiber investigations is, of course, to develop fundamental facts and to establish definite ginning practices. If these practices are adopted by ginners and growers in the various localities, the quality of their cotton should be improved and its value should ultimately be enhanced.

For many years a scientific approach to the problem of ginning was impeded both by lack of facilities for varying sufficiently and for controlling the conditions of ginning, and by lack of methods of measuring the effect upon the ginned fiber of variations in seed cotton and in the ginning processes. The establishment of a ginning laboratory especially designed and equipped for experimental work has removed the first of these obstacles, and recent developments in fiber analysis have in part removed the second.

The method employed in the ginning studies is both experimental and analytical. The equipment is designed to permit the variation over a wide range and the control within narrow limits for each of the major variables in machine design, organization, and operation, thus enabling observations to be made of the effect of varying any particular factor. These mechanical variations are for the most part susceptible of precise mathematical expression. During the tests, engineering observations are recorded relative to psychrometric and thermo-pneumatic conditions; power consumption; speeds; weights of trash, motes, lint, and seed; mechanical performance of machines; rates of ginning in terms of pounds of ginned lint per saw per hour; and other features.

The program of ginning tests has been based upon the plan of first determining each separate effect produced by the driers, cleaners, extractors, and cleaning feeders upon the seed cotton before it reaches the gin stands. This has required thousands of tests in which the cotton progressed from machine to machine both according to and differing widely from the sequences and combinations in commercial gins. This procedure was adopted not only to obtain information on the factors concerned but also to avoid erroneously attributing such effects to the gin stands proper. A wide range of drier temperatures, cleaner and saw speeds, and seed-roll densities have been employed.

The fields of engineering and fiber work already have unfolded to a point where a number of very specialized problems are visible whose solutions require vigorous and uninterrupted study by persons with highly specialized

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[1]Paper presented at a session of the Power and Machinery Division of the American Society of Agricultural Engineers during the 29th annual meeting of the Society at Athens, Georgia, June 1935. (AUTHOR'S NOTE: The material pertaining to the fiber technological phases of ginning was kindly supplied for this paper by Mr. F. L. Gerdes, associate cotton technologist, in charge of the fiber laboratories of the Division of Cotton Marketing, Bureau of Agricultural Economics, located at Stoneville, Miss.)

[2]Senior mechanical engineer, Cotton Ginning Investigations, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. ASAE.

qualifications. The limiting factor in carrying the development of adequate knowledge forward to logical completion within a reasonable time is largely a matter of personnel and facilities.

THE COTTON FARMER AND THE AGRICULTURAL ENGINEER

The cotton farmer is, in a very large measure, responsible for the condition in which the seed cotton comes to the gin, and he may be materially aided by the agricultural engineer in developing those practices which will enable him to deliver good seed cotton to the ginner, with whom he is equally obligated to exert every effort toward producing a good crop from the harvest. The farmer cannot expect the ginner to completely restore certain qualities which have been lost by undesirable methods of harvesting, nor can he evade the fact that indifference to ginning and ignorance of its processes are directly affecting his farm income. Somehow many farmers think that the market will absorb rough or damp lint without reduction in price. This is erroneous, and the farmer is learning that consumers will not knowingly buy moisture, dirt, waste, or foreign matter at cotton prices. No matter how involved may be the present system of growing, marketing, and utilization, the effects of ginning will sooner or later come right back home to the cotton farmer.

The cotton farmer, therefore, must not only assume responsibility for a reasonable share of the complaints, but must also understand that any effort on his part to improve the marketability of his product will eventually become a profitable service to himself. Heretofore the cotton farmer has contributed to haphazard ginning because the processes and results were not clearly understood. This in turn has led to inadequate gins, cut-throat competition, and doubtful practices, all of which ultimately increase the expense of the cotton farmer.

A century of experience should impress upon cotton farmers at least one vital fact; namely, that in the brief period of time required for ginning a bale of cotton is established once and for all its highest marketable and utilization value. The bale may subsequently become worse from various causes, but it has never been known to become better. The farmer cannot shirk his responsibility in the matter of what he brings to the gin, though wind, weather, and other uncontrollable elements may unavoidably damage the raw product. To the farmer, then, belongs an unquestionable responsibility to cooperate with the ginner in order to obtain from him the highest quality of service. If the ginner renders such a service, he is entitled to payment sufficiently profitable to warrant him continuing in the business.

In the light of the foregoing, it should now be clear that the agricultural engineer has a large opportunity to contribute vitally to improved cotton ginning even though his work may not deal directly with the ginning machinery as such.

PROCEDURE IN GINNING TESTS

During each test season, cotton representing wide ranges of quality were carefully selected and secured from the various sections of the cotton belt and employed in ginning tests performed by the two federal bureaus at the experimental ginning laboratory at Stoneville. The selections of cotton made and the types of ginning tests conducted were determined on the basis of problems confronting ginners and growers in the sections from which the respective cottons were obtained. In other words, if it was observed in a certain locality that inferior ginning was resulting from excessive moisture in seed cotton, necessary steps were taken to select for ginning test purposes typical seed cottons from that section. The seed cottons thus obtained were transported to the Stoneville laboratories and employed in a series of specially designed ginning tests to provide information which, when adopted by ginners and growers in specific localities, should aid materially in the solution of their ginning problems.

It may be interesting to cite a typical example. One season it was observed that a certain amount of rough ginning was prevalent in the humid section of southern Texas in the early part of the season. From this section a load of early green cotton, picked in misty weather, was sacked in canvas bags and rushed to the Stoneville laboratories by truck in order to conserve the moisture content and the original characteristics existing in the seed cotton at the time of picking. A series of ginning tests, embracing different conditioning or drying methods, was conducted on the seed cotton immediately upon its arrival at the laboratory two days after picking.

Other types of seed cotton secured under similar conditions and circumstances in the states of Mississippi, Louisiana, Arkansas, Alabama, and Tennessee, were employed in similar tests. Seed cottons were secured in practically all of these states, from mid-season and late-season pickings for ginning tests at the ginning laboratory. Elaborate cleaning and extracting tests were conducted on these cottons.

Mississippi cottons of different types, possessing various amounts of moisture content and foreign matter, were always available to the laboratory. Consequently tests on these cottons were conducted under conditions more nearly approaching those of the field than is possible in the case of cottons from other sections. Where a definite percentage of foreign matter is desired in the cottons which are immediately available at the Delta Experiment Station, a method has been evolved for mixing hand-picked and snapped cottons in proper proportions to obtain the desired content.

PROCEDURE IN FIBER STUDIES

The ginned lint samples resulting from the ginning tests, after being classed according to commercial trade practices and quality descriptions by the appeal board of review examiners in Washington, are being subjected in the Washington and Stoneville fiber laboratories, along with the corresponding seed-cotton samples, to careful analyses, involving scientific measurements and evaluations of the elements of quality which are now measurable.

The laboratory work is being done along the following lines:

Seed Cotton and Ginned Lint

1 Determination of fiber length distribution
2 Tensile strength of fibers
3 Clingability of fibers
4 Nep count and classification
5 Study of fiber structure, behavior, properties and characteristics
6 Study of seed coat structure and characteristics
7 Color determinations
8 Moisture determinations.

Seed Cotton: Determination of tenacity of attachment of fibers to seed.

Cottonseed: Studies of fibrous residue left on seed, including both quantitative and qualitative measurements.

Waste: Quantitative and qualitative analyses.

MAJOR FIBER LABORATORY STUDIES

Moisture. The moisture content of seed cotton is deemed to be so closely related to the quality of ginning that moisture determinations have been made on all the samples of seed cotton employed in the ginning tests each year and on

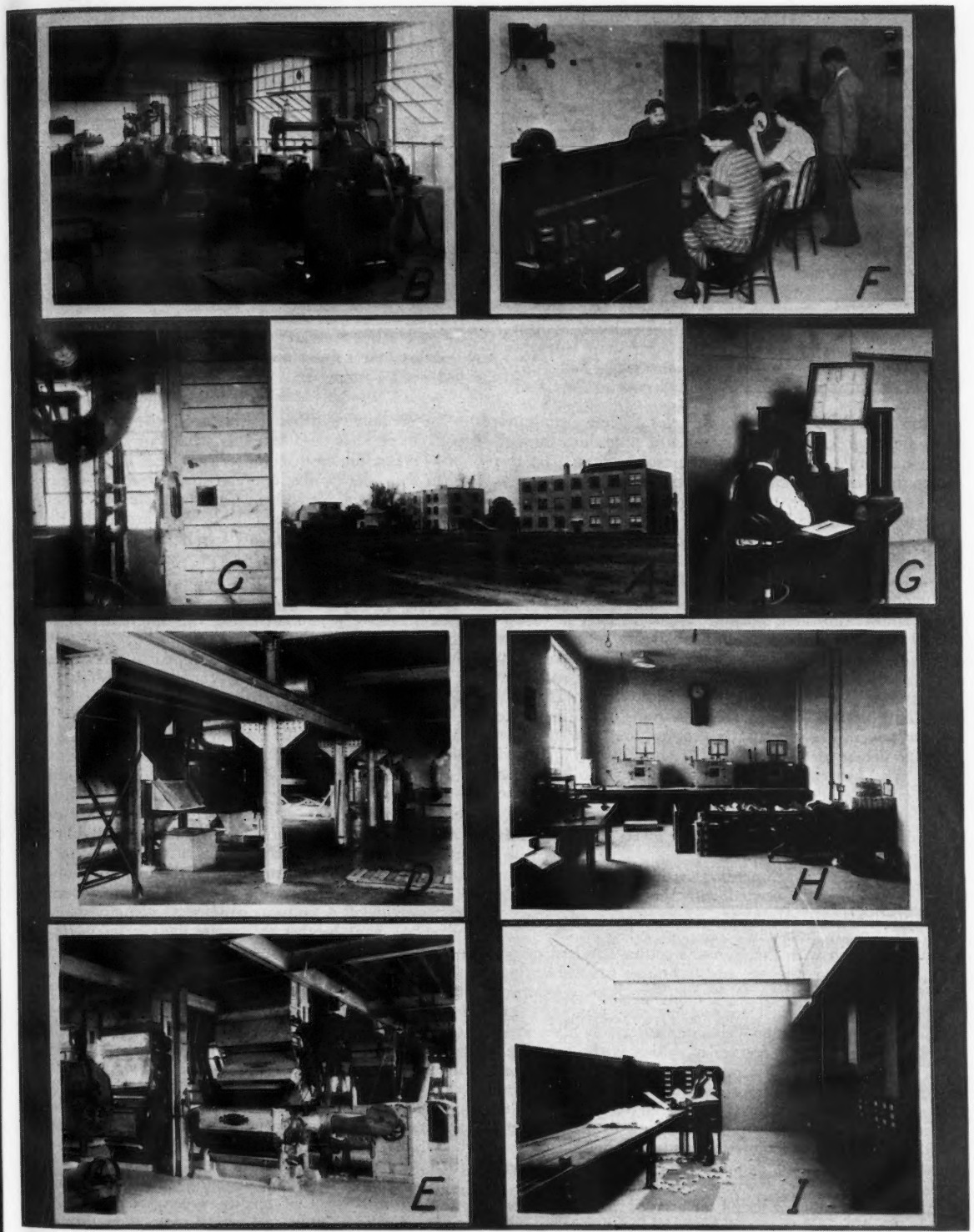
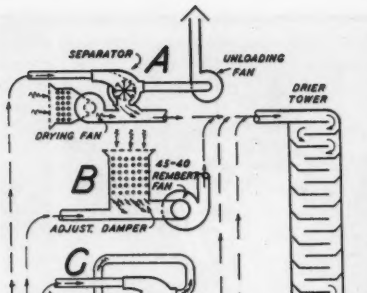


Fig. 1 A, exterior view of the cotton ginning and fiber laboratory buildings; B, interior views of ginning laboratory building—machine shop; C, a section of vertical cotton drier; D, a section of laboratory where cleaners and extractors are located; E, a section of laboratory where gin stands are tested; F, interior views of the fiber laboratory building—fiber length array laboratory; G, color laboratory; H, moisture laboratory, and I. classing laboratory. These buildings are located at Stoneville, Miss.



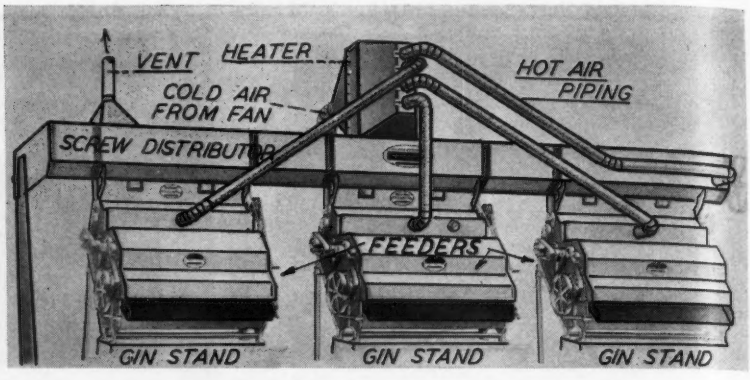


Fig. 2 (Left) Four satisfactory methods of feeding the vertical drier

Fig. 3 (Above) A factory-built drier of private design employing the government process

the corresponding ginned lint samples. These determinations are made according to a standard procedure through the use of drying ovens at the ginning laboratory. By this means the moisture content of the cotton can be known at any time during the performance of the ginning tests. Accurate information of this type is essential to proper interpretation of results and sound conclusions with respect to the effects of moisture content of seed cotton on the responses of the fibers to different ginning methods and to the quality of the resulting ginned lint.

In addition to these moisture determinations on experimental material from the ginning laboratory, other moisture determinations have been made on samples of cotton which were collected periodically from the 1931 cotton season to date from representative gins in the cotton belt. The data from these studies will provide indications of the moisture content which prevails in the cotton immediately after ginning. These data together with information gathered during field observations will be of much value in setting up experimental ginning tests this season on cottons of the localities in which moisture problems exist.

Length. Serious attention is being given to the elements of length because

1 It is the largest dimension of the fiber
2 It is closely associated with the effects of ginning methods
3 It is easily measured.

In connection with the Bureau's cotton standardization work, an improved machine and technique for the sorting of cotton fibers according to length have been developed which apply equally well to problems of ginning. The method employs the Suter-Webb duplex cotton fiber sorting machine, the major feature of which is the two fine-comb fields. The fibers of a representative sample of cotton are sorted by a series of transfers from one field of combs to the other. They are then arrayed on velvet boards in groups ranging in length from the longest to the shortest. Length arrays are made under a standard condition of the atmosphere, namely, 70 deg F, and 65 per cent relative humidity.

After each sample is sorted, or arrayed, its distribution of fiber lengths is determined by weighing the groups of fibers representing each 1/16-in interval on a micro-torsion balance and calculating the percentage by weight of each length. For the purpose of ascertaining for a given seed cotton the effect of various ginning methods on the length of the resulting samples, the length at the 25 per cent point in the cumulative array, reading from the longest fibers in each sample, has been taken as a basis of certain comparisons. It is assumed that the selected basis has more significance than any similar one chosen arbitrarily, because the cotton classer's designation for staple length frequently occurs at or near this point in the fiber array, and the best results on the spinning frame frequently are obtained with the drafting rolls set on a basis of the length at this point.

Grade. Grade, in terms of color, leaf, and preparation, is another aspect of quality which deserves special study, since it is closely associated with the different processes of conditioning, cleaning, and extracting of cotton before ginning. Methods have been developed in the laboratories of the Bureau of Agricultural Economics by Miss Dorothy Nickerson, color technologist, for measuring color in a selected area of sample adequate to represent its grade. These methods comprise measurements with a colorimeter, with which a match of the selected area may be made against the composite color of the standard disks of the colorimeter. The reading obtained from this match is conversed into the color attributes by which any color may be specified. Brilliance, which is a measure of the light-to-dark quality of color, is the chief color attribute used to determine the grade of the samples from the ginning studies.

Preparation. Preparation of cotton—that is, its smoothness, roughness, neppiness, nappiness, stringiness, etc.—is influenced, among other things, by the various methods of conditioning, handling, and ginning of seed cotton. It is generally recognized, for instance, that preparation may range from the very inferior types for certain long-staple cottons to the superior types for some short-staple cottons. Observations made by those closely associated with ginning problems and supported by findings at the ginning laboratory indicate that the inferior preparation of cotton is the result, for the most part, either of ginning early, green, sappy cotton, and late, rain-soaked cotton without adequate facilities for conditioning before ginning, or of operating gins at full capacity on long-staple cottons of even a so-called normal moisture content.

In an effort to develop methods of measuring and describing this element of quality, a series of microscopical and macroscopical studies of typical samples resulting from the ginning tests are being conducted in the laboratories of the Bureau of Agricultural Economics by Dr. Norma L. Pearson. Examinations thus far made by Dr. Pearson of these samples indicate, among other things, that there are four factors which contribute to a description of prepara-

tion. The first, and apparently the most important as well as the most conspicuous to the average cotton classer, is the amount and nature of the lumpiness and the stringiness or the "nappiness" in the lint. These "naps" are rather large, more or less tightly knotted masses of fibers, although all types of fibers may enter into their composition, thin-walled and mediumly thin-walled ones appear to predominate.

The second factor is that of "neps." The "neps" in contrast to "naps" are very small and therefore are usually inconspicuous to a high degree to the eye during an examination of the lint in bulk form. The fibers comprising them are more or less tightly knotted together and may be of all types, with the thin-walled and fuzzy fibers predominating.

The third factor is the presence in the lint of fragments of crushed motes and fragments of seed coats with their attached fibers. These may be readily confused with "neps."

The fourth factor is that of motes. These may range in size from those that are microscopic to those that are nearly as large as mature seeds. The largest possess lint of considerable length and may be confused with "naps."

On the basis of these four factors, samples representing various ginning conditions on a given lot of cotton may be compared. While considerable progress has been made in the description of the various factors entering into preparation, the process of cotton classing represents, at the present time, the only practical method of appraising this element of quality. According to this method, preparation is divided into three major classes termed "superior," "normal," and "inferior," and designated by the symbols "A," "B," and "C," respectively. Cotton below "C," or inferior, is called "gin cut."

Strength. Strength of fibers in seed cotton is recognized as being a factor which may affect the quality of ginning. A method for determining the strength of fibers which has been developed in the laboratories of the Bureau of Agricultural Economics is being applied to a study of representative samples from the ginning tests. By this method a sample of approximately 10,000 fibers, which has been uniquely prepared in a bundle, is broken in a breaking machine. The results thus obtained are expressed as breaking strength of fiber in pounds per square inch of cross section. Therefore, the strength of samples from various series of ginning tests may be compared.

DRYING AND CONDITIONING

The ginning of damp, heavy, green, or wet seed cotton may produce severe losses to the cotton farmer and at the same time prevent profitable cooperation of the ginning establishment. Between 1926 and 1928 the engineers of the Division (now Bureau) of Agricultural Engineering developed and patented a process for drying seed cotton that has come to be known as the "government process." This process is feasible for use at public gins, and may be used with any of several types of driers to provide a simple and dependable installation having sufficient capacity to supply as many as five 80-saw gin stands from one drier. Fig. 2 shows the principal features of the vertical cotton drier developed by the U. S. Cotton Ginning and Fiber Investigations, which has proved to be practical in all respects.

Our research at the cotton ginning and fiber laboratories has proved for the first time the definite facts concerning the extent of the major influence which moisture content in seed cotton exerts upon the quality of the ginned lint. Cotton-gin operation and the quality of ginned lint have been proved to be impaired when there is need for drying or other beneficial conditioning, and consequent numerous publications and official releases have been made upon this subject in an effort to acquaint ginners and the public with the importance of having the seed cotton dry when it is to be cleaned, extracted, or ginned.

Since the government process for drying seed cotton is now well-known through the drying of approximately 250,000 bales in Texas and other states, I need only briefly repeat what the process requires, namely, (1) from 40 to 100 cu ft of heated air for each pound of damp seed cotton; (2) a period of exposure from 15 sec to 3 min, depending upon the kind of drier used; and (3) a preferable temperature of 150 to 160 deg F for prime cottons, and higher temperatures up to 200 deg for late, rain-soaked cottons.

Fig. 2 outlines the vertical drier and four methods of feeding it. Homemade driers of the government design have generally proved serviceable, although it is recommended that factory-built driers be used wherever possible, because builders of homemade driers are prone to include ideas of their own in the construction and by departure from the government instructions often find themselves facing unforeseen difficulties.

Certain prominent manufacturers of cotton ginning machinery, cooperating with the U. S. Cotton Ginning and Fiber Investigations have also developed systems of drying which differ in mechanical features from the Government designs but which nevertheless employ the government process and are successfully handling thousands of bales of damp seed cotton. Fig. 3 illustrates one of these systems, which is used in connection with special types of unit extractor feeders and which accomplishes the necessary drying in conjunction with the processes of cleaning and extracting immediately prior to the ginning.

In addition to the driers illustrated in Figs. 2 and 3, there are other forms on the market which incorporate the government process of drying in the conveyor distributor of the ginning machinery, or in single or multiple revolving drums which discharge the dried cotton into the distributor.

Our research findings have now been fully verified in the results obtained from these many different forms of driers in actual operation and have convinced the more progressive growers and ginners that properly conditioned seed cotton, whether dried artificially or by some other means such as sun drying or storing, yields itself much more readily to advantageous handling through the cleaning, extracting, and ginning processes.

Our tests have brought out the fact that damp or wet seed cotton required from 14 to 23 per cent more power per gin stand than for the same cottons which were artificially dried, and that, in addition to this feature of power saving, the ginning operations were further made profitable with dried cotton, because the continuity of ginning could be maintained without interruptions from chokages or breakdowns, and because adverse weather did not prevent normal operation. The cotton technologists, in their research work relating to the cotton-fiber qualities, have shown that by drying long, wet cotton there is an average increase in value[3] of $2.50 per bale; by drying long, normal moisture content cotton, $2.00 per bale; and by drying short, wet cotton, almost $1.00 per bale. They have also verified the fact that when the temperatures of the government drying process are maintained at the lower ranges, namely, between 150 and 160 deg, for the early season cotton, there is no noticeable shortening of the fiber. They

[3]Calculations of value used in this paper were furnished by the Bureau of Agricultural Economics and are based on the average commercial prices for cotton of the various grades and staple lengths prevailing at Memphis, Tenn., during the seasons 1932-33 and 1933-34.

have also found that the germinating qualities of the seed have in general been improved by the drying processes. Fig. 4 illustrates two samples from the same cotton, the smooth one of which was ginned after being dried by means of the government process and the other one having been ginned in its original damp condition.

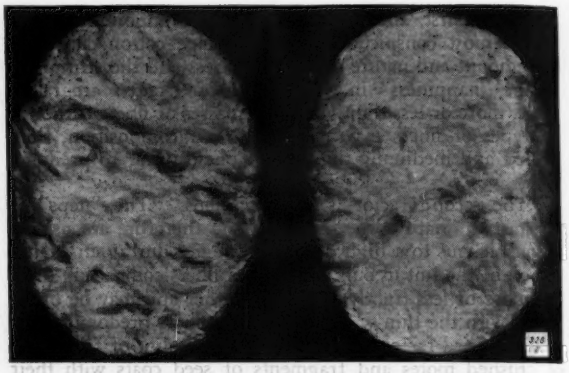
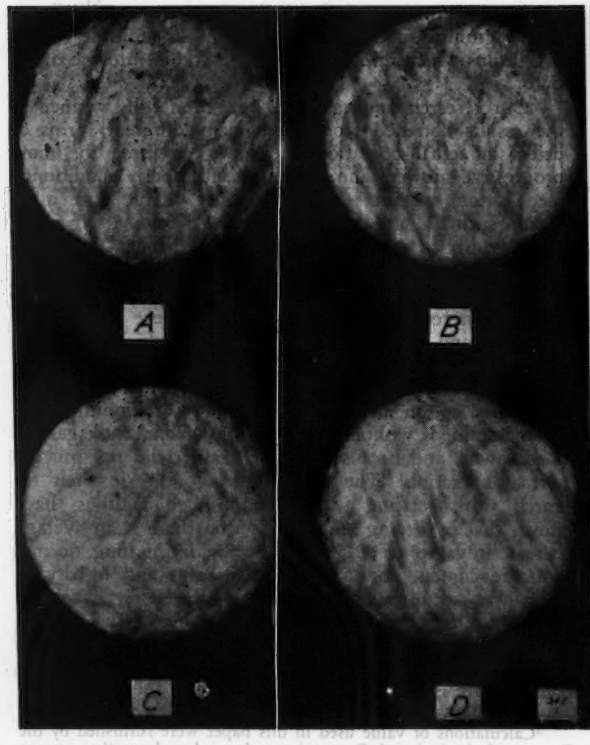


Fig. 4 Undried and artificially dried samples ginned from portions of a green and wet cotton of 1-1/16-in staple length. Left, undried; right, dried

CLEANING AND EXTRACTING

Problems of research relating to cleaning and extracting necessitate laboratory equipment representing a wide range of machines, because they are to be found individually or in combinations in so many different positions in the cotton ginning plants of the country. Since the beginning of our cotton ginning investigations, virtually all of the American manufacturers have adopted steel construction throughout and have made noticeable improvements in their cleaning and extracting machinery, especially during the past four years. For over a century the only forms of cleaning cylinders which were in use at cotton gins were wooden drums fitted with short spikes, or pieces of shafting fitted with crude paddles. Today, however, we find not only spiked-drum, paddle-wheel, and spider-arm types of cylinders, but also newly developed pentagonal and other peculiarly shaped cylinders whose performances are resulting in marked refinement in cleaner construction. We are now, therefore, faced with the problem of advising the ginner as to what combination of equipment will best serve his community, and at the same time not deprive him of profit through costs for extra power or through interest and depreciation charges on too heavy an investment.

Contrary to the opinions which formed a body of belief for many years in the cotton ginning industry, our tests are showing that in the cleaning and extracting processes the ginner is not really damaging the staple length of the product so much as he has been accused of. However, thus far even an excessive amount of cleaning and extracting machinery is unable to completely accomplish from roughly harvested cotton what simpler machinery would do from clean, hand-picked cotton. Much remains, however, to be determined with regard to the relative performance of air-line cleaners and out-of-the-air units, and during the coming season we are planning to make a more exhaustive study of this question by testing two six-cylinder machines of the same make side by side, one being arranged for air-line operation and the other as a conventional cleaner. Fig. 5 is a very interesting photographic record of the effects which various combinations of cleaning and extracting



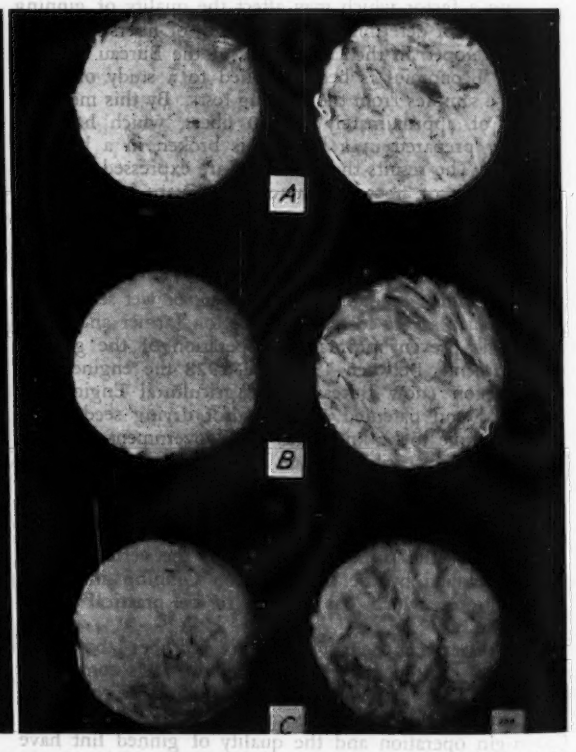


Fig. 5 (Left) Uncleaned and cleaned samples ginned from portions of a trashy cotton of 1-in staple length. A, uncleaned; B, cleaned with 6-cylinder cleaner; C, cleaned with unit extractor; D, cleaned with both 6-cylinder cleaner and unit extractor. Fig. 6 (Right) Samples ginned at different saw speeds and seed roll densities from portions of a fairly dry seed cotton of 31/32-in staple length. A, ginned at 400 rpm; B, ginned at 500 rpm; C, ginned at 600 rpm. Left, loose seed roll; right, tight seed roll

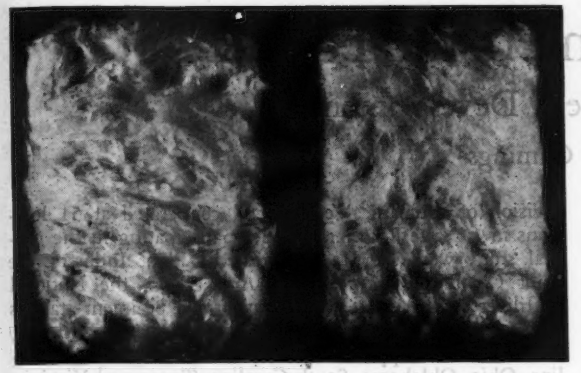


Fig. 7 (Left) Sample ginned by poor saws; (right) by good saws

machinery produce in comparison to ginning without any cleaning whatever.

COTTON GINNING ACCESSORIES

A very important part of the responsibilities assigned to the agricultural engineer in connection with the cotton ginning investigations is that which pertains to the efficiency and general effectiveness of such accessories as blowers, exhausters, air valves, and other pneumatic devices. The installation of these accessories in connection with the pneumatic handling of cotton affords a significant opportunity for improvement in the design of systems which will save power and at the same time will combine adequacy for future needs with low first costs and longevity under severe conditions of dust, dirt, sand, and other foreign matter which tend to produce a rapid wear and depreciation.

During thousands of tests we have been unable to obtain quality and quantity ginning at the same time with the existing design of machines, and our studies in the construction and operation of the gin stands are tending to indicate that certain significant departures from present-day practice may perhaps be achieved before this phase of the research work is concluded. We have, however, thoroughly proved that heavy rates of feeding seed cotton into the gin stands with the attendant tight seed rolls make poor samples, as compared to more moderate feeds and loose seed rolls. Not only do the tight seed rolls increase the power requirements almost 50 per cent, but they produce samples of ginned lint having a dollars-and-cents value much lower than those obtained from a loose seed roll.

For a large number of cottons embracing hundreds of tests, the cotton technologists' appraisal of the bale value differences between tight seed rolls and loose seed rolls is significant. Long, wet cotton, when ginned with a loose seed roll, averaged $4.00 per bale more in value than when ginned with the tight seed roll; long, normal moisture content cotton averaged $1.50 per bale more for the loose seed roll; short, wet cotton averaged $0.90 more for the loose seed roll; and short, dry cotton, $0.60 more. Fig. 6 is a photograph of samples which were ginned with loose and tight seed rolls at different saw speeds, showing clearly the primary effects of the seed roll densities and the secondary effects of changes in saw speed.

Another aspect of the gin stand operation which we are studying is that known as "doffing," which may be accomplished either by means of revolving brushes or by a pneumatic nozzle which blows the fiber from the saw teeth and discharges it into the lint flue. Present-day coton gins usually have brush cylinders of 15 to 18-in diameter with 22 to 28 brush sticks per cylinder, and we are interested in ascertaining what effect would be produced by an increase in the number of these brush sticks. The pneumatic or air blast nozzles which are frequently used in lieu of the revolving brushes for doffing the cotton from the saws have generally been operated at pressures ranging from 10 to 16 in of water, and in this connection the agricultural engineers developed a homemade air-blast gauge which any ginner could cheaply construct.

The question has many times arisen as to what may be expected from changes in saw speeds in the cotton gin, and Fig. 6 photographically portrays the answer. Our analyses of several thousand tests have indicated that saw speed variation within plus or minus 100 rpm of the manufacturer's recommended speed is secondary in effect, while seed roll density at all speeds is of primary importance. It may therefore be said that reasonable saw speed variations seldom produced significant changes, but that varying the seed roll density brought about noticeable changes in the samples.

Contrary to what was formerly believed, our tests are showing also that loose seed rolls will give as satisfactory a turn-out in pounds of lint cotton as tight rolls, although for many years some ginners have felt that well-cleaned seed could only be obtained with a tight seed roll.

The field of research in gin saws is very broad and involves the mechanical relationships between the saws and ribs, the general shapes and characteristics of gin saw teeth, the methods of saw sharpening and maintaining the saws during operation, and many other allied problems. We have proved that changes in the pitch of the teeth make a perceptible difference in the rapidity of ginning, and that the coarseness or fineness of the teeth likewise produce a marked difference in the smoothness of ginning or "preparation" of the sample. We do not yet know fully what the contributions of combinations of shape plus pitch in the gin saw tooth make in the final monetary value of the sample. There are at present straight, heavy roach, and modified roach shapes of teeth, some of which are changed slightly in their contours with every sharpening of the saw cylinders.

Since the ribs or grate bars of the cotton gins are the team-mates of the saws in ginning, there remains much to be done regarding the establishment of facts concerning shapes, position with regard to the saws, and the like. Most of the cotton gin ribs are made of cast iron, which vary in degree of hardness and which are frequently subjected to heavy wear when sand and other foreign matter is present in the seed cotton. Our tests are showing that both poor saws and poor ribs may affect not only the quality of the ginning but the quantity of turn-out as well, but thus far have not done so quite in proportion to what one might surmise from superficial comparison of their appearances with good saws and ribs.

Fig. 7 shows typical normal and inferior samples which resulted from the use of good and poor saws, respectively. Good saws, however, have generally secured a higher lint turn-out in a much shorter time—even as much as 10 lb more of lint per bale—and have done it in from 20 to 50 per cent less time than with poor saws. The appraisals of the cotton technologists regarding the value per bale of the samples which were ginned by good and poor saws disclosed the fact that the good saws increased the monetary value for long cotton by $2.00 and short cotton by $1.00.

In conclusion, it appears imperative to the agricultural engineers who are engaged in this work that quality must be made the principal objective in the cotton ginning research, since the ginning machinery of today does not yield itself to quality and quantity at one and the same time, and because the quality objective is a sound and sensible basis upon which we may hope to strengthen the position of American cotton in both foreign and domestic markets and thereby improve the position of cotton farmers and ginners.

Mechanical Placement of Fertilizers[1]

A Review of Recent Developments

By G. A. Cumings[2]

INTEREST in improved methods of fertilizer application has progressively increased during the past few years among farmers, manufacturers, research workers, and others concerned with this agricultural practice. Proper placement of fertilizer in the soil with respect to the seed or plant is now generally recognized as a factor of considerable importance in obtaining the largest returns from commercial plant food. Recent investigations have shown that the rapidity of germination of seed, early plant growth, time of maturity, quality and yields of various crops are influenced by the placement of the fertilizer. Obviously, improved methods of fertilizer application lower the unit cost of production which, in normal times, will doubtless be accomplished through increased acre yields rather than a reduction in the quantity of fertilizer applied. In a great many instances larger amounts of fertilizer could be used advantageously if properly applied. In the case of overproduction it is not conceivable that any general program of crop reduction would sacrifice fertilizer efficiency or preclude possibilities of increased efficiency.

Fertilizer distributing machinery now occupies a prominent position among agricultural machines when we consider the number of units in use, the importance of supplying deficient plant foods, and the advantages of improved methods of fertilizer application. The census shows that 2,324,090 farmers in the United States were using commercial fertilizer in 1929. It is estimated that over 5,000,000 units of fertilizer distributing machines and attachments are now in use.

The possibility of materially increasing the crop returns with little additional expense to the farmer accounts for the rapid expansion of research studies of fertilizer placement. The Department of Agriculture estimated that fertilizers were utilized in 1929 with an efficiency of only 50 per cent. It is believed that a marked increase in efficiency can be obtained through more effective methods of fertilizer application. An appraisal of the advantages of improved methods of fertilizer application for any crop or any area would be difficult on account of the great diversity of conditions to be considered. However, from the experimental evidence recently collected the improvement and development of inexpensive fertilizer depositing devices appear to have possibilities for considerable economic advantage to the farmer.

The influence of placement on fertilizer efficiency was studied on an extensive scale in 1934. The current findings of a major part of the investigational work were presented at the tenth annual meeting of the national Joint Committee on Fertilizer Application, in Washington, D. C., on November 21. These studies, known as machine placement of fertilizers, were conducted in 1934 with snap, lima, and white beans, cabbage, corn, cotton, potatoes, sugar beets, tobacco, and tomatoes at 54 locations in 19 states. The U. S. Bureau of Agricultural Engineering, through its division of mechanical equipment, cooperated at 51 locations in 17 states. Other agencies participating in the general study were the U. S. Bureau of Plant Industry, the Joint Committee on Fertilizer Application, the National Fertilizer Association, and agricultural experiment stations in Georgia, Indiana, Louisiana, Maine, Maryland, Michigan, Missouri, Mississippi, New Jersey, New York, North Carolina, Ohio, Oklahoma, South Carolina, Texas, and Virginia. Other investigations related or similar to those mentioned were in progress. The present extensive program which has been further expanded this season, gradually developed during the past five years even though the funds of research agencies were materially reduced. The Bureau of Agricultural Engineering has extended its cooperation on fertilizer placement work to the point where it is no longer possible, because of limited funds, to comply with many requests from state and federal agencies for engineering assistance.

Any discussion of recent findings must necessarily be limited to general statements. The influence of fertilizer placement varies considerably with the crop, the kind and amount of fertilizer, the type of soil, soil moisture, weather conditions, and other factors. Broadcasting of fertilizer has previously been shown to be less effective than row application with most widely spaced row crops. In 1934 the application of fertilizer at time of planting in a narrow band at each side of the row was, in general, found most advantageous for beans, cotton, potatoes, and tobacco, and for the relatively large amounts of mixed fertilizers applied to sugar beets. With these crops, which were grown in various states, the average yields and crop values resulting from side placement of the fertilizer were, in general, about 20 per cent greater than those obtained from the less advantageous placements of equal amounts of fertilizer. A side placement about 2 inches from the row and 3 inches below ground level was indicated as most desirable. A band at only one side was as effective as a band at each side of the row with snap beans, cotton, and sugar beets, the only crops for which such a comparison is available. In practically all cases a larger number of plants came up where fertilizer was properly applied than where no fertilizer was used. With cabbage and tomatoes, grown under abnormally dry conditions, differences in the efficiency of fertilizers placed in various positions with respect to the transplanted seedling were evident. Side placement at the hill for checked corn had previously been shown to be most effective.

Placement of relatively large amounts of fertilizer in a band immediately under or mixed with the soil around the seed or seedling roots in general reduces the stands and yields of beans, cotton, potatoes, and tobacco. Any fertilizer placement which necessitates the disturbance of the soil under the seed is likely to be at a disadvantage, unless rain or irrigation follows immediately to supply moisture and re-establish capillarity. With unfertilized crops we have found that disturbance of a firm seedbed frequently delayed germination of the seed and reduced the number of plants appearing above ground. With a fertilizer placement 2 inches under cotton seed, we found that compacting dis-

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[1]Paper presented before the Power and Machinery Division at the 29th annual meeting of the American Society of Agricultural Engineers at Athens, Georgia, June 17 to 20, 1935.

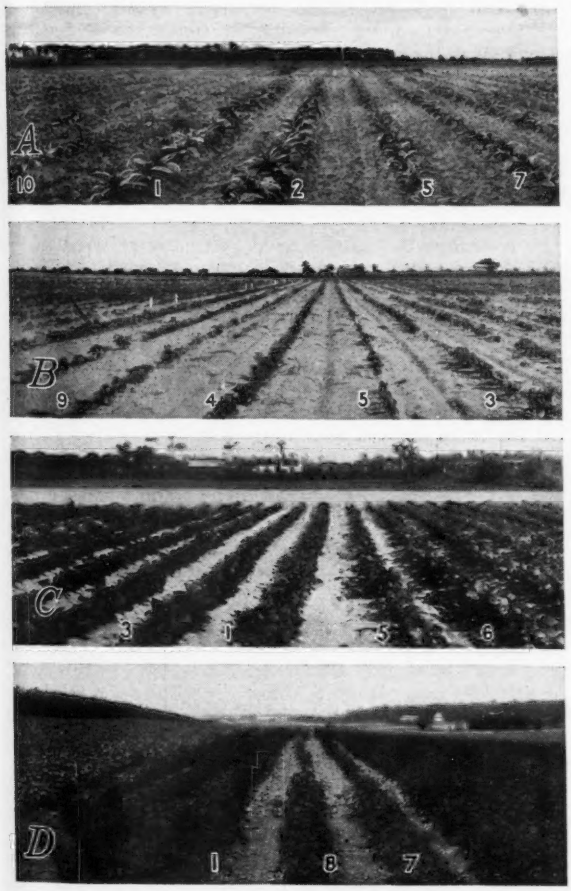
[2]Agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. ASAE.

turbed soil under the seed greatly increased the rapidity and percentage germination when moisture conditions were not highly favorable. Instead of opening a seed furrow in the usual manner, a wheel with a 1.5-inch tire was used to press the seed into the soil approximately 1 inch, thus compacting the soil to a considerable extent. The immediate benefit of this practice depends somewhat on the moisture and mechanical conditions of the soil.

Typical effects of fertilizer placement on plant growth are shown in the accompanying illustration.

A number of practical demonstrations on farms by the use of improved fertilizer placement machinery substantiates the experimental results. To what extent fertilizer efficiency could be increased by improved application methods and machinery for the country as a whole could hardly be estimated. Average increases in yield of 20 bushels of potatoes, 500 pounds of snap beans, and 100 pounds of lint cotton an acre doubtless could be obtained by better placement of fertilizer in many cases where relatively large amounts are improperly applied.

The major facility of the Bureau of Agricultural Engineering for the fertilizer machinery project is a laboratory building 55 by 110 feet containing two air-conditioned rooms, a shop, and special testing apparatus, located on the Arlington Experiment Farm of the U. S. Department of Agriculture at Rosslyn, Va., near Washington.



Typical differences in crop development resulting from representative placements of equal amounts of fertilizer with respect to either the seed or seedling. A, tobacco; B, cotton; C, snap beans; D, potatoes. 1, band 2 inches to each side, 3 inches below ground surface; 2, band 2 inches to each side, 5 inches below ground surface; 3, band 4 inches to each side, 3 inches below ground surface; 4, band 4 inches to one side, 3 inches below ground surface; 5, band 1 inch under seed; 6, band 3 inches under seed; 7, mixed with soil in the row; 8, in furrow with seed; 9, "bedded on" 8 days before planting; 10, mixed with soil in the row, plants set by hand (a local method)

In conducting fertilizer placement experiments either new machines or special attachments must be constructed to meet the varied requirements. The Bureau of Agricultural Engineering now has 15 special machines, and others are under construction. This equipment is designed for experimental work only.

Standard units are employed for planting the seed, and their performance must necessarily be closely observed since uniform and accurate planting is particularly essential in experimental work. Even though planting mechanisms have been developed to a high state of perfection, the accuracy with which the seed are spaced in the furrow is not always satisfactory. When planting potatoes and seeds such as beans and peas, closely spaced in the row, it has been noted that the seed are delivered uniformly from the hopper, but, due to bouncing in the delivery tube and possibly other causes, the seed are deposited irregularly in the soil. Discussion of this particular point has recently been noted in the literature from England.

Recent developments of fertilizer-distributing machines have been gradual compared to some of the revolutionary developments of certain larger units of agricultural machines. While fertilizer-distributing equipment used in connection with planters and drills has generally been known as attachments, we now find, in some instances, that the fertilizer distributor is the predominating factor in the design of these combination machines. Usually more satisfactory results are obtained when planting and fertilizing mechanisms are both treated as integral parts of a combination machine.

The recent extensive research activities have stimulated the development of improved fertilizer-distributing machinery. The changes necessary to obtain approved placement of the fertilizer depends largely on the existing practices and the type of equipment involved. It may be only a matter of adjustment, a new design of an inexpensive depositor, and in a few cases a rearrangement of the machine. In general, improved placement of the fertilizer can be obtained at a nominal cost.

One of the recent developments of importance is the improvement of fertilizer depositors for corn planters. These new depositors place the fertilizer in a short band at each side of the hill, a little above the seed level for checked corn, or in continuous bands for drilled corn. The depositor is simply a boot with valve and hooded divider which is attached at the rear of the seed shoe. These depositors are now available on most makes of corn planters. While these new devices satisfactorily apply and permit much more efficient utilization of the fertilizer, it would not be in keeping with the times to say that further improvement is impossible. Some authorities suggest that the fertilizer is most effective when placed below the level of the corn seed. The most recent depositor announced is in the form of a duplex shoe designed to deposit the fertilizer and seed at different levels. The claim is made that the fertilizer is deposited in a band at one side and below the level of the seed. No records are available on the practicability of this device.

In the case of potato planters several manufacturers have either installed the necessary attachments or provided adjustments to permit placement of the fertilizer at seed level in a band at each side of the row. The common depositor consists of a pair of disk-furrow openers with delivery tubes, or boots, to insure delivery of the fertilizer to the bottom of the furrow. The demand for this equip-

ment differs among the potato-growing sections. In the northeastern potato sections where a ton or more of fertilizer is applied per acre and other crops are not grown to any extent, the growers are demanding and buying the most modern equipment available. Equipped with approved fertilizer placement devices, two-row tractor planters are sold in large numbers and a number of four-row planters are in use. In sections where large amounts of fertilizer are applied, and other crops as well as potatoes are grown extensively, the modern large-scale potato planters with fertilizer equipment have not been sold in large numbers. Farm practices have been developed to meet the local situation with less expensive machinery. An inexpensive distributor can be used to apply fertilizer for potatoes as well as other crops. The advantages of improved fertilizer placement are recognized more generally, and gradual adoption of the most modern machines is now taking place in some of these sections.

In potato sections where small amounts of fertilizer are applied, the side placement of fertilizer is not so markedly superior to other row applications, and the trends in the use of fertilizer equipment are not so definite.

For cotton, provision has been made on some tractor planters for applying fertilizer in a band at the side of the row. This equipment was demonstrated in the southeastern area last year. A number of growers are in a position to use such equipment. A two-horse combined cotton planter and fertilizer distributor for placing fertilizer in a band at each side of the row was put on the market and demonstrated in the Southeast last year. I understand another similar machine will soon be placed on the market. It is less difficult to accomplish the necessary operations with these larger units, and they can doubtless be successfully used in a great many instances. The farm practice which involves the use of the so-called one-mule machines has been developed and quite extensively followed in the production of cotton and other crops for certain basic reasons. To what extent this practice might be successfully changed through the adoption of other types of equipment I am not prepared to state. The possibilities of developing, for the above-mentioned farm practice, a one-mule machine of the single-row walking type which will plant seed and place fertilizer at the side of the row, and yet be compact, reasonably light, and easily managed under some of the existing conditions, are as yet undetermined.

A method of obtaining side placement of the fertilizer with the one-mule equipment has been used in southern Alabama for several years. By means of a depositor on a simple distributor the fertilizer is placed in two parallel bands with the wheel mark between. The planter then follows and plants the seed between the fertilizer bands. This system has considerable merit, but two operations are required and fertilizer placement is less accurate than when the seed and fertilizer are deposited simultaneously.

Bean growers are now demanding machinery equipped for side placement of the fertilizer. In certain sections the use of one-mule equipment at present is required and improved equipment of this general type has not yet been placed on the market. For other areas single-row, two-horse machines and multiple-row, bean-planting outfits have been placed on the market during the past year. It has been reported that the application of fertilizer with this improved equipment gave highly satisfactory results. Prior to the introduction of these machines, I inspected several home-made devices of a similar nature which were successfully used.

Fertilizer depositors for sugar beet drills have been developed, although the most advantageous placement of the fertilizer has not yet been definitely determined. One of these drills, designed for side placement of the fertilizer, did not meet with the desired success and has been taken off the market. In the particular instance in question, the fertilizer was placed at a distance of several inches from the row. From our experience it is believed that the small amounts of fertilizer ordinarily used in the western areas is most effective when placed relatively close to the seed. Fertilizer attachments for sugar beet cultivators have been placed on the market for side dressing the fertilizer after the plants come up.

One of the recent developments for grain drills is the mounting of the fertilizer tube several inches back of the seed shoe in such a position that the fertilizer is deposited above the seed. The fertilizer does not come in contact with the seed. Records indicating the results that might be expected with small grains have not come to my attention. In our experiment with cannery peas at Geneva, N. Y., this season, a grain drill was employed and the fertilizer placement mentioned above was included; so far as germination of the seed and early plant growth are concerned the fertilizer placement above the seed was far superior to the local practice of drilling the fertilizer in the furrow with the seed, but perhaps not equal to some of the other placements in the study.

Various improvements and developments of fertilizer equipment for use in connection with transplanters, vegetable and truck crop drills, and other machines have been undertaken. The lack of experimental results with the different crops has, in a number of cases, retarded progress toward the adoption of improved machine designs. With additional information regarding fertilizer application, we may anticipate further development of fertilizer-distributing machinery and its adaptation to new requirements.

A change to which I have previously referred is the increased interest of growers in improved methods of fertilizer applications, shown by the increased number of inquiries as well as the increased demands and purchases of improved machines.

In this connection it might be mentioned that demonstrations have been made by implement manufacturers and the agricultural extension service. The first major activity of the extension service dealing specifically with fertilizer placement was inaugurated this year in New Jersey. Suitable fertilizer placement equipment was transported from one farm to another, and field demonstrations were started with several crops.

The use of corrosion-resistant metals and coatings has been given some attention. Fertilizers greatly accelerate corrosion. A limited use of corrosion-resistant metal for certain light, adjustable, or moving parts of distributing equipment could be accomplished with a reasonable expense and would be of great advantage. An example of this trend is that of a corn-planter fertilizer depositor recently placed on the market, the inside and outside surfaces of which are coated with white porcelain.

Among the recent developments affecting the operation of distributors is the improvement in mechanical condition or drilling properties of a large percentage of the fertilizers now on the market. The drilling properties of much fertilizer has been improved by changes in manufacturing processes and the subsequent handling of the materials. The improved mechanical condition of the fertiliezr obviates many difficulties in the performance of all distributing equipment. The gradual improvement of fertilizer distributing machines and better drilling properties of many fertilizers have greatly lessened the difficulties encountered in the mechanical application of fertilizers.

Precast Concrete Joists in Farm Structures

By F. A. Lyman[1]

LACK OF FIRE protection on the farm, often resulting in heavy financial loss such as wiping out of a dairy herd, made it almost inevitable that any new, simplified and more economical system of fireproof floor construction would soon attract itself to some farm owner planning to build.

Recent research has developed a method of concrete floor construction utilizing precast joists, combining these qualities of economy and simplification for buildings of relatively light floor loadings[2].

As a result, use of precast joists for farm structures has been pioneered in a Pennsylvania farm house and in a large dairy barn in Minnesota during recent months.

Probably due to the fact that precast joists are manufactured chiefly by established concrete products plants in urban areas, it was natural that first wide-spread application of this method of low-cost concrete floor construction was to urban and suburban homes.

Late in 1933 more than 100 small homes constructed by the Tennessee Valley Authority at Norris, Tennessee, employed this type of floor construction. Establishment of more than 100 precast joist plants within the past two years in all parts of the United States has so far resulted in use of this floor system in several hundred city and suburban homes, schools, and small commercial buildings.

The dairy barn referred to above has recently been completed near Mapleton, Minnesota, on a farm operated by Miller and Son. It is a large barn, 38 feet 8 inches by 74 feet, with a 12 by 12-foot utility room on the side closest to the house. Cost of the barn complete, including $500 of barn equipment, was approximately $4,500. This barn was designed and constructed with a concrete hay loft floor in order to provide an incombustible shield between the hay in the loft and the dairy cows and other livestock below.

This principle of farm-building construction has in several instances resulted in the saving of valuable dairy herds when large lofts full of hay burned. In one recent case coming to the writer's attention, a large mow full of hay burned out on a concrete floor in a barn near Waukesha, Wisconsin. One hundred head of purebred dairy cows were in the barn when the fire broke out and were removed without loss or injury while the hay was burning furiously overhead. Hardly before the fire had burned itself out, the cattle had been put back in the barn with a weather-tight "roof" over their heads. The superstructure of the barn was later rebuilt using the same concrete floor and masonry walls.

Joists in the Miller and Son barn are 8 inches deep by 3 inches wide, modified I-beam shape. The joists have a compression bar in the top flange, a heavier tension bar in the bottom, with necessary steel stirrups to furnish sheer reinforcing and hold the reinforcing bars in position. The stirrups extend through the top of the joist to provide anchorage in the concrete slab, providing for T-beam action.

Joists are spaced in four spans of approximately 9 feet 6 inches each and one end span of 12 feet. A reinforced concrete tie beam 12 inches wide by 11 inches deep runs entirely around the barn at loft floor level. Joists are placed flush with top of the beam with a bearing of 4½ inches. Another reinforced beam 8 by 10 inches was constructed entirely around the barn 24 inches above loft floor level, to which the roof plates are anchored.

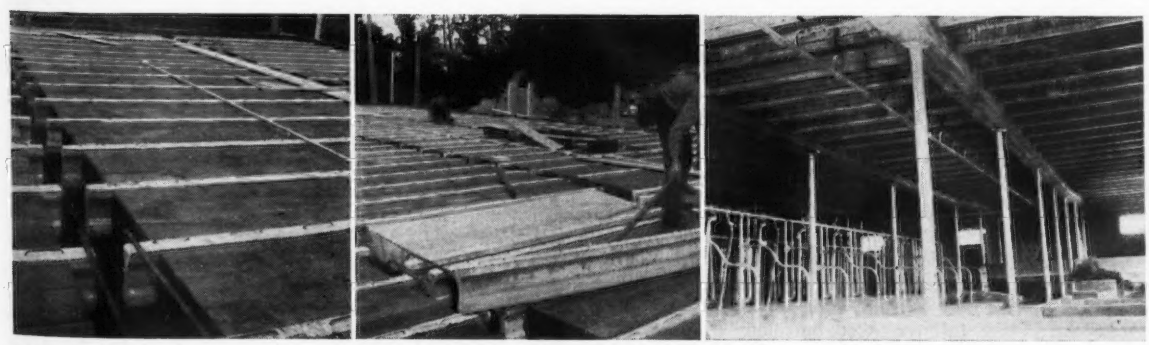
Reinforced concrete beams 12 inches deep on steel posts approximately 10 feet on centers furnish interior support. After the joists were in place, these beams and the floor slab, 3 inches thick, were cast integrally in order to provide the desired head room. Where head room is not at a premium, a more economical method might be to bed the joists on a beam constructed by spacing two concrete joists parallel to each other, 3 inches apart, reinforcing this space and filling with concrete to make a triple-joist beam, cast prior to placing the floor slab.

Joists are spaced 24 inches on centers, except under an oats bin 12 by 12 feet partitioned off on the hay mow floor. Under this bin the joists are placed 12 inches on center. Clearance to bottom of concrete joists is 8 feet.

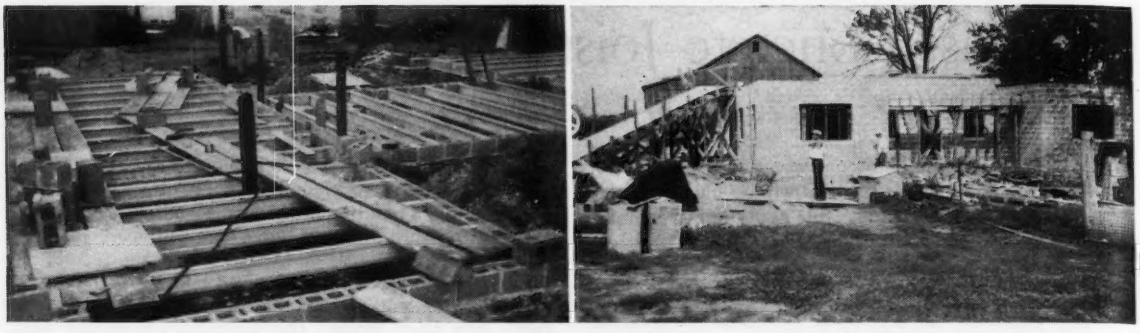
Forms for the floor slab were supported on the joist flanges with the bottom of the slab extending about ½ inch down from top of the joists. This method of placing combined with the stirrups extending from the joists into the slab has, by numerous tests, provided adequate bond to set up T-beam action. The slab is reinforced with plain

[1]Agricultural engineer, Portland Cement Association. Assoc. Mem. ASAE.

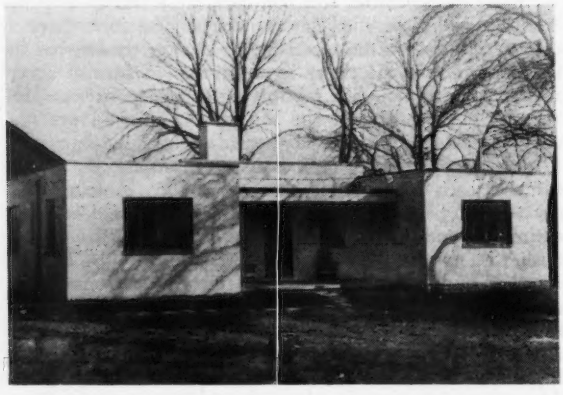
[2]New Idea in the Construction of Low-Cost Concrete Floors, by W. G. Kaiser, AGRICULTURAL ENGINEERING, September 1934, vol. 15, no. 9.



Three construction views of the dairy barn of Miller and Son near Mapleton, Minn., in which precast concrete joists were used. (Left) Floor forms and reinforcing for beams in place; joists extend 4½ inches into the beams. (Middle) This view shows the size and shape of the precast joists. (Right) An interior view of the completed barn



Two construction views of the Big Brothers Association farmhouse showing use of precast concrete joists (left) and walls completed ready for roof construction (right). A substantial saving was made by use of a flat-roof design



A view of the farmhouse of the Big Brothers Association near South Langhorne, Pa., shortly after it was completed in the fall of 1934

welded wire fabric 6 by 6 inches, 10 by 16 gauge. Conduits for electrical wiring were placed in the slab.

Cost of this construction, according to the contractor, did not exceed that of conventional combustible floor construction by more than $150, and with the experience gained on this job he feels confident that this difference could be further decreased.

The entire barn, except roof, doors, and a few interior details, is of concrete construction. Footings and foundation below grade are cast-in-place concrete, with 10-inch double concrete masonry walls above grade. Reinforced concrete lintels, sills, and door jambs were used.

The Miller and Son barn was constructed by Worthley Crib and Silo Company, Mankato, Minnesota. Equipment installation was designed and manufactured by the Hudson Manufacturing Company.

In July 1934 the house on the farm owned and operated near South Langhorne, Pa., by the Big Brothers Association of Philadelphia, burned. The Association members act as "big brothers" to underprivileged boys between the ages of 12 and 18. In addition to the farm operator and his wife and a superintendent, the house built to replace the burned dwelling has dormitory facilities for boys who are brought to the farm for periods ranging from six months to two years. Usually, from four to eight boys are cared for at a time.

Fireproof construction was sought for the new dwelling, resulting in a design employing concrete masonry walls and precast joist concrete floor and roof. The house is one story, with full concreted basement and flat roof. The building was designed and dimensions determined by multiples of standard 8 by 8 by 16-inch concrete masonry units and half units. Plywood was used for forms to cast roof and floor slabs. Roof concrete was placed first, as joist spacing was wider than for the floor, enabling the form material to be ripped and reused. Inch-thick Celotex insulation covered with tar and slag was placed on top of the roof slab.

Joists are 8 inches deep, doubled beneath partitions. Use of the standard units, automatically spaced the joists. Roof spacing was 2½ units, or approximately 40 inches. First floor spacing was 2 units, or 32 inches. Ceilings were finished with two coats of portland cement paint applied directly to the slab and left exposed.

Walls are of cinder block, finished on exterior and interior with two coats of portland cement paint. Although furring and plastering is usually regarded as desirable for a wall of this type, the occupants report that they found the dwelling unusually easy to heat during the cold weather of last winter.

Metal basement sash was used for all windows, with precast concrete sills. Precast coping was made on the job.

Cubical content of the building is 29,800 feet. Contract price, including extras, was $6,359.74. The extras included such items as enclosing back porch, a concrete roof and floor for the cold storage cellar, electric range, and electric pump. Heating is by a forced-circulation hot air system with thermostatic control. Cost per cubic foot was 21.4 cents. Roof and floor construction costs were 34.1 cents per square foot. Exterior walls, painted two coats on both sides, cost 25.9 cents per square foot. The four coats of paint cost a total of 5.4 cents per square foot.

Improved Rural Fire-Fighting

STANDARDIZATION of farm fire protection methods to enable volunteer fire departments to give prompt service in case of fire is recommended in a rural fire protection program prepared by engineers of the U. S. Department of Agriculture, as follows:

1 Organization, equipment, training, and maintenance of a rural fire department in every community.

2 Arrangement for suitable fire alarm systems to assure prompt fire department service.

3 Provision of adequate water-storage facilities on farms and near rural public buildings for fire-fighting purposes.

4 Installation, maintenance, and correct use of fire extinguishers and fire appliances in farm and rural buildings.

5 Provision for runways for fire department pumpers to available streams and ponds to prevent miring and to asssure prompt service.

An Electricity Consumers' Cooperative[1]

By Geo. W. Kable[2]

THE ALCORN County (Mississippi) Power Association is the first mutual, non-profit association in the Tennessee Valley organized for the purchase and distribution of electric energy. It was created by the citizens of Alcorn County early in 1934 and undertook the active distribution of power on June 1 of that year. The underlying principles of the Association are those of the original Rochdale Society of Equitable Pioneers organized in England on December 21, 1844. They provide for a non-profit organization conducted for the benefit of members. Each member is limited to one vote in the affairs of the association, regardless of stock owned or purchases made, and votes cannot be cast by proxies. Capital contributed as membership fees or otherwise is paid interest only and does not participate otherwise in the earnings. Earnings are refunded as dividends to members in proportion to the amount of purchases made. Some of the outstanding features of the Alcorn association are presented on the accompanying chart. Further details of the organization are contained in the by-laws of the association, which may be obtained from the Information Division, Tennessee Valley Authority at Knoxville, Tennessee.

The chief purpose of the association is to provide its members and others with electric service at cost. In accomplishing this object the corporation is empowered to purchase, construct, or acquire distribution systems in or adjacent to Alcorn County. It is authorized to purchase electric energy at wholesale from the Tennessee Valley Authority and to distribute it to members and others for any purpose. It may also engage in the buying and selling of electrical supplies and equipment, and in the wiring of houses. All enterprises must be conducted at cost and without profit. Up to the present time the Alcorn association has limited its activity to the distribution of electric energy. Equipment sales have been handled by local dealers, who have cooperated closely with the association in the maintenance of displays and in other promotional activities. Where dealers approved by the Electric Home and Farm Authority sell equipment financed by that agency, the association acts for the Authority in collecting and forwarding the monthly amortized payments.

Membership in the Association is open to all persons, firms, municipalities, associations, etc., having property to be served electrically. The membership fee is $100. If paid in full with the application, the amount is reduced 20 per cent. For partial cash payments the amount is reduced proportionately. In practice, most members make a down payment of $10 and small monthly payments until the membership fee is liquidated. If paid monthly, the amount is one cent per kilowatt-hour of electricity used, with a minimum of 25 cents and a maximum of $1.00. Persons desiring to become members must make application, pay the initial deposit on the membership fee, agree to abide by the by-laws of the association, and be accepted by the board of managers. A separate membership must be taken for each detached piece of property or each separate meter service. Each individual, however, has only one vote regardless of the number of the memberships taken. Memberships are transferable from person to person, or one property to another, on approval of the board. Persons moving from the service area may sell their memberships, or the corporation may repurchase the memberships.

Consumers who were being served at the time the association was formed and transients may be served as non-members. The rates for non-member service are enough higher than for members to cover capital charges and other service costs.

No applicant for service will be connected until his wiring has been approved by the corporation.

Government of the association is by the members at the annual and special meetings, and by a board of five managers elected by the members. Board members are elected for a period of three years and serve without pay. In the newer Pontotoc County Power Association the board of managers is replaced by a board of directors representing school districts within the association area. The directors at their first meeting elect an executive committee of five members who have the general management of the corporation. The board of managers, or executive committee, selects the paid personnel of the association, including a superintendent, who has the responsibility for the general management and operation of the properties.

Rates to members of the Alcorn association are TVA rates, plus any deferred payment on membership fees as previously noted. Rates are the same for rural and residential customers, this being one of the outstanding features of the TVA rate structure. The following rates apply to general farm service using transformers up to 5-Kva. capacity: First 50 kwh, 3 cents; next 150 kwh, 2 cents; next 200 kwh, 1 cent; next 1000 kwh, 0.4 cent; all over 1400 kwh, 0.75 cent. Minimum bills vary from 75 cents to $1.50, depending on the size of meter installed.

The method of disposition of revenues is made a part of the by-laws of the association. The earnings are first applied to operating expenses, including taxes and other obligations. Thereafter reserves are set aside for new construction, depreciation, and contingencies. All membership fees and surpluses, except a working capital of $2,500, are applied to retirement of the debt on the distribution system. When the distribution system debt is paid, membership fees will be discontinued and any surpluses will be returned to members through reduced rates, or refund of membership payments, as the board may decide.

The Tennessee Valley Authority has contracted to furnish power at wholesale to the Alcorn association for a period of twenty years. It has financed the purchase of the existing distribution system at an interest rate of 3½ per cent, and has agreed to build additions to the distribution system up to 100 miles of line, costing not to exceed $125,000. Retail rates to consumers must have the approval of the Authority, which also prescribes the accounting methods and has access to the association's books.

Alcorn County is in most respects a typical southern county, with cotton and corn as its main crops. It is located in the northeast corner of Mississippi about fifty miles from Muscle Shoals. The population of the county is approximately 23,700, with about 6,700 urban residents and 17,000 rural. The percentage of negroes is high. In 1930 Alcorn County had 3,384 farms, of which 1,972, or 59.1

[1]Paper presented at a session of the Rural Electric Division during the 29th annual meeting of the American Society of Agricultural Engineers at Athens, Georgia, June 17 to 20, 1935.

[2]Senior designing engineer, agricultural-industry division, Tennessee Valley Authority.

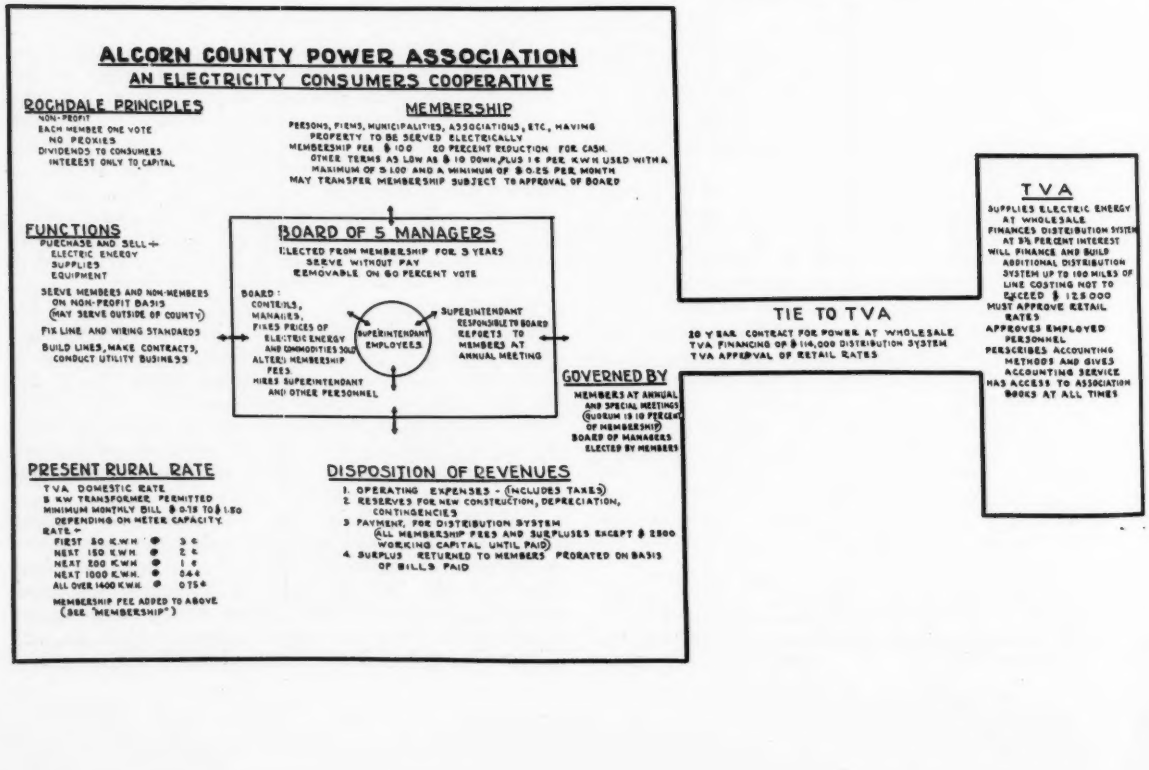
per cent, were operated by tenants. Forty-eight farms had central station service and 34 had individual lighting plants. Electric motors were used on only ten farms. The average amount of the bills paid to the power companies was $46.70 per farm per year. Prior to June 1, 1934, electric service was supplied by the Mississippi Power Company. On that date the electrical properties in the county were purchased by the Tennessee Valley Authority and resold to the Alcorn County Electric Power Association. The property consisted of the distribution system serving the town of Corinth and a few miles of rural line. The purchase price was $115,000, payable to the TVA from revenues of the association.

The Alcorn association differs in several respects from the usual farmer's association. It combines urban and rural members in one organization for their mutual benefit, with urban members and service predominating at present. It also serves non-members who were receiving service from the electric system at the time the association was formed. The combination of urban and rural service under a uniform distribution policy has points of merit for all localities. It is working out particularly well in Alcorn County. Corinth is the county seat and the trading point for the rural sections. It is the center of cultural and business life of the county, but it depends for its existence upon the trade of the farmers. The interests of town and country are therefore mutual interests.

The partnership of town and country in the distribution of electricity has reciprocal advantages. Electricity is purchased by the association at wholesale rates on a block basis. By increasing the total consumption of power without a corresponding increase in maximum demand, a larger amount of energy may be purchased in the lower blocks of the rate. As farm uses for electricity increase, the diversity between town and country will lower the demand factor in relation to the total consumption, and lower the cost to all consumers. Moreover, the staff required for urban service can also handle much of the operation of the rural system, with a consequent reduction in operating costs. The advantage to rural customers is obvious. Rural lines which might be unprofitable to serve if considered as a separate unit, may often be operated without loss if made a part of a larger system. Since the overhead of serving a rural line as part of a larger system does not increase the total overhead proportionately, such rural lines may be built so long as the increment of cost does not increase the total cost per kilowatt-hour of service. The Alcorn association will not serve new customers except as members, but it did give existing customers the choice of being served as members or non-members. The difference in member and non-member rates tends to make memberships attractive to minimum bill customers, who obtain only 11 kilowatt-hours for their $1.00 minimum as non-members, or 25 kilowatt-hours for their 75-cent minimum as members.

The records of the Alcorn County association to date are encouraging. In the first six months of operation the total number of customers increased from 1,599 to 1,627. About one-half of all customers became members in the first few days of operation. At the present time there are approximately 2,000 customers, of which about 15 per cent are non-members. In recent months 50 additional miles of rural lines have been put in service. Residential consumption jumped from 49 kilowatt-hours per customer per month in May, the last month of the Mississippi Power Company service, to 83 kilowatt-hours at the end of the seventh month. During the first seven months of association operations, the average rate to residential customers declined from 3.1 cents to 2.6 cents per kilowatt-hour, due to increased consumption. At the same time total residential revenue increased 13 per cent. The wholesale rate to the association was approximately 5.8 mills per kilowatt-hour. In the first six months the domestic load was increased by the addition of 211 refrigerators, 90 ranges, and 32 water heaters.

Gross revenue for the first year, exclusive of membership fees and amortization charges, and adjusted for changes in billing dates, was $79,000. After deducting cost of power, distribution, taxes, depreciation, and interest, there remained a balance of *(Continued on page 407)*



Terrace Outlet Control[1]

By H. O. Hill[2]

TERRACING has been practiced in the United States for more than a century. It has only been within the past few years, however, that any concerted effort has been made to control the erosion at the terrace outlets, which inevitably occurs if there is a dropoff at the outlet end of the terrace.

One of the greatest obstacles to an expanding erosion control program is the problem of terrace outlet control. In any area where terracing is such an important erosion control measure as in the Blacklands, careful consideration must be given to the proper designing of the terracing system. Since such a system is only as permanent as the outlets, special attention must be given to the proper design for protecting them permanently.

Terraces should never be emptied directly into a road ditch unless it is of suitable size and grade to carry the additional runoff water without overflowing or eroding, and unless the ditch will not have to be reworked with heavy road-grading machinery. Such locations are very rare, so it is generally recommended that, instead of emptying into the road ditch, the terraces empty into a controlled outlet ditch within the boundaries of the farmer's field. With the outlet ditch so located the farmer is in better position to maintain the outlet control measures and to be rewarded by their continued satisfactory performance. All terrace outlet ditches should be located in such a manner that the greatest number of acres may be controlled with the minimum cost of terrace outlet protection. Such protection requires that terraces be brought into the outlet structures from both sides of the ditch, where possible. This type of ditch is well adapted for use as a community ditch on the boundary of two farms with both farmers emptying their runoff into it, as an outlet near the center of a large field having long terraces, or as a cooperative outlet ditch in which the neighbors cooperate with each other and allow the terraces to run from one farm into the other.

In many cases it is possible to design the terrace system so that meadows or well-sodded pasture land and wooded areas may be used as an outlet for the terrace runoff water. Such outlets should be used if available because there is no cost to this protection. Good judgment must be exercised in determining whether or not the vegetative covering is sufficient to withstand the erosive action of the terrace water.

The "rational" method is used for determining the amount of runoff water to be used in the design of terrace outlet structures and ditches. This formula is

$$Q = CIA$$

in which Q = runoff in cubic feet per second
C = coefficient of imperviousness
I = rainfall intensity in cubic feet per second, per acre. (This is practically the same as rainfall in inches per hour, which is used in computations)
A = area in acres.

The coefficients (C) used are as follows for different types of land use:

	Cultivated	Pasture	Timber
Hilly, 20 to 30 per cent	0.72	0.42	0.21
Rollying, 5 to 10 per cent	0.60	0.36	0.18

Mr. C. E. Ramser has done extensive work on runoff discharge measurements from small agricultural areas, and recommends that an additional reduction may be given for runoff from terraced areas less than 100 acres. This reduction as given in the following table is applied to the discharge as computed by the above formula:

Area in acres	Ratio of runoff from terraced land to that from unterraced land
1	0.60
10	0.70
30	0.75
100	0.90
Over 100	1.00

A rainfall intensity of 6 inches per hour is used for this area. This intensity is that which records shows is likely to occur in this area once in ten years for a 15-minute period. The time of concentration for most small terraced cultivated areas is calculated to be about 15 minutes. At the end of this period all parts of the area will be contributing to the flow, and the runoff discharge will then be at its maximum.

After the runoff has been computed, outlet ditches, terrace outlet structures, erosion check dams, and other control structures are designed to discharge the runoff water from the area above them.

Most check dams and terrace outlet structures are designed with a rectangular weir notch. This notch is in most cases comparable with a broad-crested weir and may be designed by the formula

$$Q = 3.39\,LH^{3/2}$$

where Q = discharge in cubic feet per second
L = length of weir in feet
H = depth of notch or head on crest of weir in feet.

This formula does not consider the velocity of approach of the water in the ditch, which is on the side of safety.

An excellent explanation of the above procedure and formulas is given in a mimeographed pamphlet, entitled "Brief Instructions on Methods of Gully Control," by C. E. Ramser, senior drainage engineer, Soil Conservation Service, U. S. Department of Agriculture.

In the Blackland area it is recommended that 0.5 per cent is the maximum grade to allow between the lip of the apron of one structure and the crest of the weir on the next one below. This grade is varied from 0.5 per cent to level, depending upon the soil type on which the structures are located. Recent observations indicate that it would be desirable in practically all cases to drop a curtain wall below the lip of the structure in such a manner that the bottom of the curtain wall will be level with the crest of the weir on the structure below.

The foregoing discussion relates to the design of mechanical structures for the control of terrace outlets. There are two methods of controlling runoff water from terraced areas to prevent excessive erosion in the terrace outlets and in the outlet ditches. One is by means of mechanical struc-

[1]Paper presented at a meeting of the Southwest Section of the American Society of Agricultural Engineers at Tyler, Texas, July 10, 1935.

[2]Chief agricultural engineer, Elm Creek Watershed (Project No. 4), Soil Conservation Service, U. S. Department of Agriculture. Jun. ASAE.

tures, and the other, which will be taken up later, is by means of vegetation.

Mechanical structures should be divided into temporary and permanent, and since a terrace system is a permanent installation, it is obvious that only permanent terrace outlet control should be installed. Native material should be used where possible and available for this construction work. In the Blackland region there is a very limited supply of durable native rock available, and, as a result, a large portion of the outlet control structures on the Elm Creek project have been constructed of concrete in various forms.

Terrace outlet structures in general have the form of a small overfall dam. The water comes down the ditch, through the weir notch, and falls upon an apron where the velocity is partially dissipated. The apron has side walls which extend from the top of the weir to the end of the apron and from the top of the apron lip as far up the bank as the weir is deep. These apron side walls prevent the water from washing the dirt away from the wing walls. The wing walls are vertical cutoff walls, in the same plane with the weir notch, which extend into the terrace ridges on each side of the notch. There is a lip or small vertical wall on the downstream end of the apron which forms a stilling basin and assists in dissipating the energy of the falling water. The backwall of the apron, under the crest of the weir notch, should extend below the apron a sufficient amount to form an effective cutoff wall. There should also be a cutoff or curtain wall under the lip of the apron.

Permanent terrace outlet control structures have been built of rock masonry, formed concrete, concrete blocks, concrete-filled sacks, concrete without the use of form work, combination concrete without form work and block-topped wing walls, and combination concrete using one-half forms and block-top wing walls.

Rock masonry structures are built with vertical walls and rectangular weir notches. The small amount of durable rock that is available is very rough and odd shaped, having no definite cleavage plane. For this reason and because there is a good quality of pit run gravel available at a reasonable price, rock masonry structures are built with a 1 to 6 mixture of portland cement and gravel instead of a cement-sand mortar. Rock masonry structures are well adapted for low overfall structures under most conditions encountered in terrace outlet and gully control work.

Structures built of concrete without the use of form work can be readily and economically constructed in locations where terrace outlet channels and outlet ditches have been excavated to about weir level. The excavation is prepared to proper size and the back and side walls are sloped one-half horizontal to one vertical. The reinforcement as designed is then placed, and the concrete is tamped into place on these sloping walls. Form work is only necessary where the wing walls of the structure rise above weir level or solid earth.

A combination structure of formless concrete below weir level, with side and wing walls above weir level built of solid concrete blocks 5 by 5 by 18 inches and 5 by 5 by 12 inches, laid up as in cut-stone practice, has been used to advantage. This type of construction entirely eliminates the necessity of forms for building a concrete structure. It is the cost of forms that generally makes concrete structures cost more than other types when only a small number are built.

Another combination structure has been developed, using one-half forms and a vertical walled earth excavation for pouring the concrete below weir level; above weir level solid concrete blocks are laid in a cement-sand mortar as in masonry practice.

All of these "formless" structures are dependent upon a stable earth excavation for all walls below weir level. For this reason they can only be used advantageously in locations where this condition can be met, and are not adapted for construction in gullies or terrace outlet ditches that are badly washed. In these locations the concrete-filled sack and formed concrete structures can be used very satisfactorily.

Sack concrete structures have been developed and used for gully control structures and check dams in badly eroded outlet ditches where conditions of topography demand flexibility. In building the structures, burlap bags are filled about three-fourths full of concrete composed of one part portland cement to seven parts good grade bank run sand and gravel. The mix is placed wet in the sacks with enough water to hydrate the cement, but not enough to make the handling of the sacks difficult. After the apron and foundation of reinforced concrete with dowels placed under the wall sections have set, the sacks are then laid in place in the walls with the joints broken as in masonry construction. No mortar is used between the joints but the courses of sacks are dowelled together with U-shaped bars of reinforcing steel driven into adjoining sacks and through several courses. For heights up to 4 feet these structures are built with vertical walls and for greater heights, the weir section of the structure is built in a flat arch. Sack concrete structures are particularly adapted for locations where excess ground water is encountered in the excavation.

The formed concrete and concrete block construction is fully explained by their names. These types have been used very little on account of their excessive costs. The cost of formed concrete structures decreases very materially if large numbers are built and adjustable forms are used that can be removed without damage and reset on similar dams.

A summary of the different type structures, their relative cost, and advantages and disadvantages are listed in Table 1 in order of their relative importance for use in this area.

VEGETATIVE CONTROL OF TERRACE OUTLETS AND OUTLET DITCHES

PREPARATION OF THE OUTLETS. The controlling factor or the success of well-established vegetation in resisting erosion depends upon the velocity and volume of the water flowing over the vegetation. Practically no data is available on the resistance that various vegetative coverings offer to erosion under different velocities. It is therefore necessary for a considerable amount of research work to be done in connection with vegetative outlets and vegetative outlet ditches. The vegetation is the permanent control for the outlet ditch, and spreaders or other temporary structures are used only to assist in spreading the water during and after the period when the vegetation is becoming established.

DESIGN OF OUTLET DITCH. The preparation of a successful vegetative outlet or outlet ditch is preceded by the designing. A preliminary survey must be made before designing; this includes the area drained and the slope of the outlet or ditch. In the Elm Creek watershed the "rational" method is used to determine the amount of runoff for a ten-year frequency. Manning's ditch formula is used to determine the size of a vegetative ditch in which the velocity of the water will not exceed five feet per second. This formula is

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

in which Q = discharge in cubic feet per second

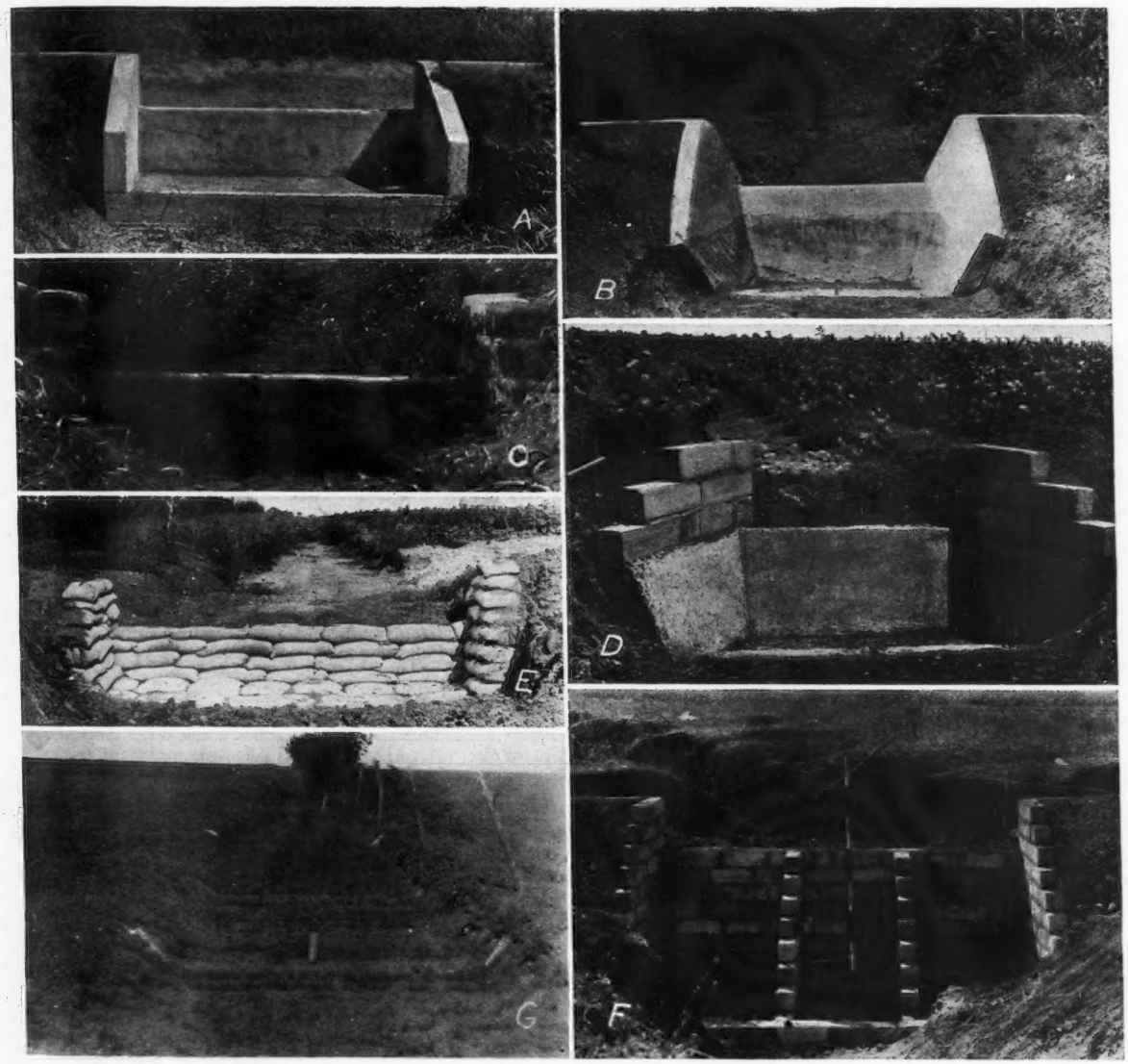
A = area of water cross-section in square feet

R = hydraulic radius of the ditch section in feet
S = slope of channel bed
n = coefficient of roughness of channel (0.03 is used for channels covered with vegetation).

In designing vegetative outlet ditches it is advisable to allow from 4 to 8 inches of extra depth for grass growth and silting during low-velocity flows.

After the outlet ditch or the outlet has been designed, it is staked out on the ground and then roughly built with a fresno or slip scraper. After the rough excavation is complete, the spreaders are built with a level width the same as the ditch and a 1½ to 1 slope on the sides. The ditch is then graded out with no abrupt changes between spreaders and the bottom level from side to side.

SPREADERS FOR USE IN VEGETATIVE OUTLET DITCHES. Whenever vegetation is used to control erosion in a channel, it is advisable to use erosion checks until the vegetation is well established. These checks are spoken of as spreaders, and are especially necessary when the terraces are completed before a good stand of vegetation has been developed. It is also believed that these spreaders may prevent gully washing due to dry weather cracks in the ground. Spreaders are placed at strategic points in the ditch, usually one



A variety of types of terrace outlet control structures. (A) A formed concrete check dam and terrace outlet structures which controls erosion at the ends of terraces entering ditch from each side. (B) A terrace outlet control structure built of concrete without the use of form work except where the walls rise above solid earth. The excavation walls are sloped ½ to 1 and the concrete is placed on these sloping walls. (C) This rock masonry structure prevents excessive erosion in the terrace outlet ditch and prevents gullying in the terrace channel which enters the structure from the right. The vegetation around the structure helps to prevent cracks from forming and allowing the runoff water to wash around the ends. (D) A terrace outlet control structure built of concrete without the use of form work below weir level and of precast concrete block above weir level. The walls of the excavation are sloped ½ to 1 and the concrete poured against them below weir level. The wings extending into the terrace ridge on each side are poured into a vertically excavated trench. This type of construction eliminates all necessity for form work. (E) A terrace outlet and outlet ditch control structure built of concrete-filled burlap bags laid as in masonry practice without mortar joints but doweled with vertical reinforcing steel. The aprons and foundations of the structures should be built of reinforced concrete. (F) This structure of precast concrete blocks controls a badly gullied terrace outlet ditch and the outlets of terraces entering immediately above the structure from each side. This type of construction is more satisfactory if placed on a poured concrete apron. (G) A vegetative outlet ditch designed for a velocity of 5 feet per second. The bottom of the ditch is flat and level concrete spreaders keep the depth of the runoff water as uniform as possible across the ditch bottom. The staff gauge in the ditch is used to determine the depth of water for computing the maximum velocities attained

at every terrace outlet and at every break in the slope. Observations at present show that this method of spacing is satisfactory, but future results may dictate changes. On this project spreaders have been built of creosoted timber, concrete sacks, and poured concrete. The creosoted timber spreaders were made of 2 by 12 lumber treated with a hot and cold process. These treated boards were sawed to the required lengths and placed in ditches and backfilled. The concrete sack spreaders were made by filling burlap bags about three-fourths full of wet concrete mixture about one to seven proportion cement and pit-run gravel. They were placed two layers deep in a ditch with the joints broken. Then U-shaped, 3/8-inch reinforcing bars were driven through the two layers, tying the top sacks together at each joint. The concrete spreaders were made by digging a trench 4 inches wide and 12 inches deep in the solid earth of the ditch, then filling this with a regular concrete mixture. One bar of 3/8-inch steel was used for temperature reinforcement.

The concrete spreader is the most economical of all three, and, as a result, we have adopted its use for our project.

TYPE OF VEGETATION USED. The vegetation for this type of erosion control work must possess extensive root

TABLE 1. RELATIVE COSTS AND ADVANTAGES AND DISADVANTAGES OF THE DIFFERENT TYPES OF TERRACE OUTLET CONTROL STRUCTURES

TYPE OF STRUCTURE	RELATIVE COSTS OF CONSTRUCTION	ADVANTAGES	DISADVANTAGES
Formless concrete	< Rock masonry < Formed concrete < Concrete block = Concrete sack = Combination formless and concrete block top = Combination one-half formed concrete and block top	1 Low cost 2 Built without complicated forms 3 Simplicity of construction 4 Less erosion and cutting around structure	1 Requires stable earth excavation for construction 2 Requires careful construction
Sack concrete	= Formless concrete < Rock masonry = Combination formless concrete and block top = Combination one-half formed concrete and block top < Formed concrete < Concrete block	1 Flexibility 2 Adaptable to washed ditches and gullies 3 No form work required 4 Simplicity of construction 5 Can be built intermittently, under adverse weather and ground water conditions	1 More material needed for small structures 2 Requires careful construction
Rock masonry	> Formless concrete < Formed concrete < Concrete blocks > Concrete sack > Combination formless concrete and block top > Combination one-half formed concrete and block top	1 Low cost 2 Simplicity of construction 3 Adaptable to washed ditches and gullies	1 Requires available native materials 2 Not adaptable to high structures
Combination formless concrete with block top	= Formless concrete < Rock masonry < Formed concrete < Concrete blocks = Concrete sacks = Combination one-half formed concrete and block top	1 Low cost 2 Built without form work 3 Simplicity of construction 4 Less erosion and undercutting around structure	1 Requires stable earth excavation for construction 2 Requires careful construction
Combination one-half formed concrete with block top	= Formless concrete < Rock masonry = Combination formless concrete and block top < Formed concrete < Block concrete = Concrete sacks	1 Low cost 2 Less erosion and undercutting around structures	1 Requires stable earth excavation for construction 2 Requires careful construction 3 Form work difficult
Formed concrete	> Formless concrete > Rock masonry > Combination formless concrete and block top > Combination one-half formed concrete and block top > Sack concrete = Concrete block	1 Uniformity of strength 2 Better construction in unstable earth	1 High cost 2 Complicated form work 3 More erosion around structures
Concrete block	> Formless concrete > Rock masonry > Combination formless concrete and block top > Combination one-half formed concrete and block top > Sack concrete = Formed concrete	1 Can be constructed intermittently and piecemeal	1 High cost 2 Requires careful construction 3 Requires stable foundation 4 Adaptable to small structures only

= equal to
> greater than
< less than

systems, have a long growing season, produce abundant although not rank vegetation, and be of the turf-forming type. Any vegetation that is apt to become noxious should be avoided, and in all cases the cooperator should be consulted before it is planted.

The vegetative work done in terrace outlets and outlet ditches has been with grasses and other plants. The vegetation that we are using includes Bermuda, buffalo, paspalum distichum, Panicum obtusum, Dallis grass sod, and Lippia. Italian rye is sown in the fall to give temporary protection while the sod is becoming established.

Several methods of planting the sod have been used to get the vegetation started. From observations made to date the method which has proven to be most successful, with the exception of ditches completely covered with sod, is to dig trenches about five inches deep, six inches wide, and eight inches apart across the outlet and outlet ditch. Well-rotted manure is then spread over the bottom of the trenches and a layer of good top soil put on top of the manure. The sod is then placed in these trenches and a layer of soil put on the top and sides of the trenches and thoroughly tamped. It is very important that the sides of the terrace outlets and outlet ditches be well sodded.

Recently we have been using another method of planting the sod. A series of holes about 5 inches deep across the channel of the outlets were bored with a post hole auger. The holes are spaced about 12 inches apart in rows and the rows about 12 inches apart. The holes are so arranged that they stagger rather than line up. The sod is then planted in the same manner as for the trenches.

From observations made, the Bermuda grass, because of its more soil-binding root system, more vigorous and prolific growth has shown best results. But since Bermuda grass is very noxious, cooperators are prone to be skeptical of its use close to cultivated fields. Buffalo grass has given only fair results as it is somewhat slower in starting growth, but may thrive better on the more upland places than Bermuda. The paspalum distinchum and Panicum obtusum (wire grass) are very promising, especially in places where moisture is more plentiful. So far the use of Dallas grass is very doubtful since it is a tufted grass and not adapted to hot, dry summers. Orderly grazing of the sodded areas in outlets and outlet ditches will cause the grass to spread quicker, which will hasten the complete sodding over of terrace outlets and outlet ditches.

SUMMARY. In order to investigate the holding capacities of different vegetative coverings under various velocities, ditches have been designed which will give a velocity from 1 to 15 feet per second. All vegetative ditches are inspected after each runoff to determine the maximum depth of water, apparent erosion, condition of channel, condition of vegetation, and other important factors. From these data the actual maximum velocity that each ditch section attained is computed after every inspection.

The data is then compiled and a frequency curve drawn, showing the relation between silting and erosion at different velocities as developed in the ditches. Curves are drawn for the different degrees of vegetative coverings which are classified as good, fair, and poor vegetation.

From these curves it is evident that we must design for a maximum velocity as well as for a minimum velocity of water in vegetative channels. The sections of ditches with good vegetation that attained a velocity of 2 feet per second or less have silted enough during the past six months to force the water out of the ditch. Ditches that attained a velocity of 8 feet per second or more have eroded very badly. Ditches with velocities between 3½ and 5½ feet per second are functioning properly.

An Electricity Consumers' Cooperative

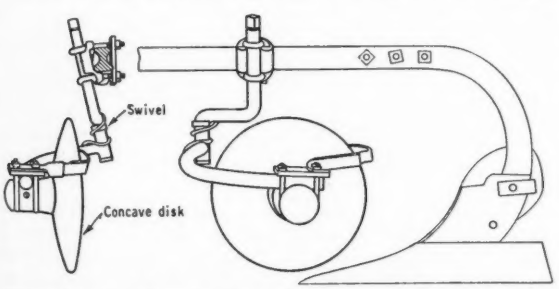
(Continued from page 402)

$26,750, or 35 per cent of the gross income available for retirement of debt, new construction, or emergencies. Additional rural lines put in service during that period have brought the association's investment to $225,000, but it has already amortized $55,000 of its indebtedness, and owed only $170,000 as of May 31, 1935. At this rate of earning the entire present indebtedness will be paid off in from four to five years. Assuming an additional investment in rural lines of $125,000, or a total plant value of $350,000, the association should be free of debt in from six to eight years.

A New Aid to Clean Plowing

THE self-angling disk jointer plow attachment, shown in the accompanying sketch, was designed by engineers of the U. S. Bureau of Agricultural Engineering for better coverage of trash in plowing. Tests show this attachment also reduces the draft of plows by 10 to 15 per cent, compared with draft of plows equipped with regular rolling colters and jointers.

The self-angling disk jointer is comparatively simple in design, and the Bureau has been granted a public-service patent on the invention.



This sketch shows the self-angling disk jointer designed by engineers of the U. S. Bureau of Agricultural Engineering

The attachment has a concave disk which cuts and aids in turning under the edge of the furrow slice nearest the unplowed land, just ahead of the moldboard of the plow. The disk is mounted so that it is free to move about the vertical standard to which it is attached, but always assumes a position practically parallel to the plow travel. When the disk strikes a root, stone, or other solid object, the attachment will not be damaged, because the shank and arm permit the disk to swing to the side and upward to clear the obstruction, after which it returns to its normal position.

Ordinarily in trash coverage, colters and jointers are used to cut the edge of the furrow slice and to aid in the turning under of vegetation. These attachments are sometimes difficult to adjust and in certain soils may interfere with the operation of the plow by causing non-scouring of the plow bottom, or by restricting the clearance of the plow and reducing its capacity to pass trash through without clogging. When these conditions prevail, farmers remove the moldboard jointer. The self-angling disk jointer minimizes these difficulties.

Electric Pasteurization of Milk[1]

By B. E. Getchell[2]

AFTER YEARS of research and investigation Louis Pasteur, in 1864, presented to the world the first rudimentary principles of the process which we, in his honor, term "pasteurization." The application of Pasteur's discoveries to the milk industry was slow, and it was not until about the turn of the 20th century that pasteurized milk was generally offered to the American public. Since its introduction in this country, pasteurization has been increasingly demanded, and the present tendency is to pasteurize practically all milk sold for fluid consumption.

For the regulation of commercial pasteurization, the U. S. Public Health Service, as a result of extensive research, has defined milk pasteurization as being 143 degrees (Fahrenheit), held 30 minutes, termed the holder method, or 160 degrees, held 15 seconds, termed the high-temperature method.

However beneficial pasteurization has proven itself to be, the alterations of flavor and cream frequently encountered in pasteurized milk have led to objections on the part of the public. It is quite apparent, therefore, that the further development of pasteurization must concern itself with the problem of eliminating these objectionable features.

Research shows that damage to the flavor, cream, and food values of milk is the result of overheating or holding the milk over too long a period of time at pasteurizing temperature. The range between the point at which sufficient bacterial destruction is assured and the point at which these damages occur is clearly defined, and any deviation beyond the limits of this range results either in insufficient bactericidal action or in alterations of the physical properties of the milk. The first step, then, in eliminating the objectionable features of pasteurized milk is the application of this knowledge in an attempt to discover wherein and why deviations beyond these limits occur.

Until the present time, commercial pasteurization has been accomplished by placing the milk in contact with heated surfaces. Milk, unfortunately, is such a poor heat conductor that, when a quantity of it is thus heated, wide differences of temperature appear in its various portions. Therefore, it is quite obvious that the efficiency of this pasteurization method depends basicly upon the ability of the milk to absorb heat from external means and upon the design of the pasteurizer for mechanically transmitting this heat throughout the entire volume of the milk. It naturally follows that, unless the mechanical distribution of this heat is nearly perfect, in warming all portions of the entire volume of the milk so that it will insure sufficient bacterial destruction, there is the definite danger of subjecting certain portions to temperatures high enough to damage the flavor, cream, and food value of the entire quantity. Thus it is seen that alteration in flavor and cream may frequently result from conduction pasteurization. And the conclusion is logically reached that the solution to the problem of their elimination lies in the adoption of some method of heat production that does not depend upon the uncertainties of heat conduction.

Electric pasteurization offers a definite and positive solution of this problem in that the passage of electric current directly through the milk results in the production of heat actually within the substances of the milk itself, and proper mechanical construction insures an absolutely uniform generation of heat throughout all portions of the milk.

For more than twenty years it has been known that electric pasteurization will overcome the objectionable features of ordinary pasteurized milk, and many attempts have been made to make electric pasteurization applicable on a commercial scale. These attempts have largely fallen short of their goal because of the failure to develop and employ automatic electric control devices sufficiently accurate to hold the temperature within the necessary range and sufficiently rugged to withstand the conditions met in commercial operation.

Extensive experience in the design and manufacture of automatic electric control equipment led the engineers of the company with which the author is connected to attempt the solution of this problem of commercial electric pasteurization. As a result of their efforts, they believe they have definitely succeeded in perfecting an electric pasteurizing unit that will, under commercial conditions, produce the results that laboratory science has repeatedly shown electric pasteurization to be capable of producing.

By making electric pasteurization on a commercially practical scale possible, the dairy industry is provided with an ideal method of overcoming the public's objections to pasteurized milk, and with the means of elevating the general level of public health through the inevitable increase in milk consumption.

The bactericidal efficiency of electric pasteurization has been the subject of much scientific investigation. These investigations show quite definitely that electric pasteurization not only destroys all the harmful bacteria commonly found in milk, but that it is also an effective safeguard against certain varieties of bacteria on which other methods of pasteurization have little or no effect.

The superiority of electric pasteurization over other methods is plainly shown by a comparison between the bacterial content of conduction pasteurized milk distributed in Boston, and of that produced by two electric pasteurizers in commercial use near Hartford, Conn.

The Boston health department report for December 1933 lists results of examinations on Grade A and B milk as distributed by 91 dealers. The lowest count was 3000 bacteria per cubic centimeter, the highest 27,000. This milk did not exceed 500,000 bacteria per cubic centimeter before pasteurizing.

During the past four months, numerous bacterial examinations have been made of milk processed by the two aforementioned electric pasteurizers. These examinations were made by the health departments of the state of Connecticut, Hartford, New Britain, and Boston. The lowest count was 30 bacteria per cubic centimeter, the highest 600. The bacterial content of this milk before pasteurization ranged from 1,000 to 2,000,000 bacteria per cubic centimeter.

These and other results of scientific investigation show conclusively that in pasteurizing efficiency electric pasteurization far surpasses any other method yet devised. Other pasteurizing methods may be capable of a comparable reduction in the total number of living bacteria present, but in achieving this reduction the natural characteristics of the

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[1]Paper presented before the Rural Electric Division at the 29th annual meeting of the American Society of Agricultural Engineers at Athens, Georgia, June 17 to 20, 1935.

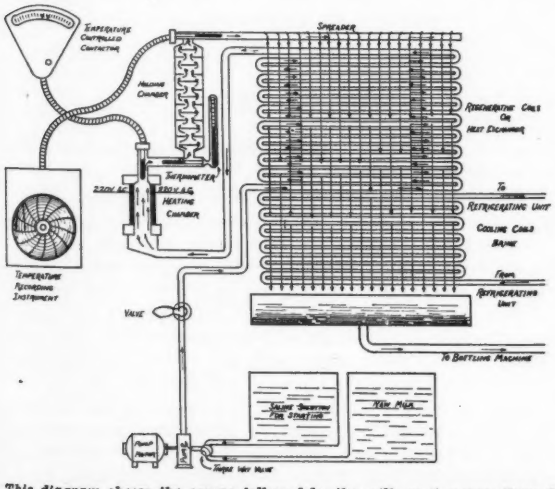
[2]Designing engineer, Trumbull Electric Manufacturing Co.

milk are so impaired as to render the milk practically worthless. Electrical pasteurization, however, does not impair, even in the slightest degree, the natural milk properties.

Despite the fact that high-temperature pasteurization embodies several features of definite advantage in the handling and bottling of milk, the short holding time of this method serves to greatly emphasize the aforementioned difficulties confronting all conduction pasteurization, and is responsible for the reluctant adoption of the high-temperature method.

The electric pasteurizer entirely avoids these difficulties and makes available the desirable features of high-temperature pasteurization, thus providing the dairy industry with fast, dependable pasteurizing equipment which will automatically produce pasteurized milk efficiently, the flavor and cream of which are indistinguishable from that of the original raw product, and the keeping qualities of which are greatly enhanced.

COURSE OF MILK FLOW. The accompanying diagram shows the course followed by the milk as it passes through the electric pasteurizer. The milk is taken from the supply tank by an electrically driven pump and passes through a control valve to the heat-exchange coil. The design of the heat-exchange coil is such that as the raw milk passes through the interior of the coil it is warmed to about 125 degrees (Fahrenheit) by an exchange of heat from the already pasteurized milk flowing downward over the outer surface of the coil. From the coil the milk enters the bottom of the heating chamber. In this heating chamber, or electrode chamber, the milk becomes the conducting medium through which flows a regulated 220-volt alternating current. This passage of electricity through the milk heats it to a pasteurizing temperature of 160 degrees or over, for which the control device has been set. As it leaves the electrode chamber, the milk flows by the bulbs of the control instrument and the indicating thermometer, and enters the holding chamber which is so designed that it takes 15 seconds for the milk to pass through, thus holding it the required length of time at the pasteurizing temperature. On leaving the holding chamber, the milk passes into the spreader pipe where it comes in contact with the bulb of the recording thermometer which records the milk temperature. The milk is released from the upper surface of the spreader pipe and flows downward over the outer surface of the heat-exchange coil where it gives up part of its heat to the incoming raw milk, as previously explained.



This diagram shows the course followed by the milk as it passes through the Trumbull electro-pasteurizer

The milk leaves the heat-exchange coil at a temperature of approximately 85 degrees. Here the milk is either collected for cream separation at this temperature, or is allowed to flow downward over the water and brine cooling coils, reaching the receiving trough at the proper bottling temperature.

ELECTRODE CHAMBER. The electrode chamber is rectangular in cross section and varies in length according to the capacity of equipment. Its two opposite walls are made of carbon plates or electrodes spaced apart by heavy glass separators or insulators which comprise the other two walls of the chamber; 220-volt alternating current is connected to the carbon electrodes, and in its passage through the chamber the milk provides a conducting medium for the flow of current and its resistance to this flow generates heat within the body of the milk itself.

To prevent the carbon electrodes from becoming overheated, they are kept cool by a flow of cold water over their outer surfaces.

TAKE-OFF TROUGH. The desirable temperature for cream separation is about 85 degrees. This is approximately the temperature at which milk leaves the heat-exchange coil. In order to facilitate collection of the milk at this point a take-off trough is provided. This take-off trough is placed in operation by tilting the cooling coil slightly backward. The milk then passes from the heat-exchange coil directly into the receiving trough at the proper separating temperature.

MILK SPREADER PIPE. Of outstanding merit is the new type spreader pipe employed in the electric pasteurizer. Here the milk is released to the heat-exchange coil from the *top* of the pipe rather than from the bottom as is the usual practice. This upward discharge prevents any formation of the foam pockets generally encountered in ordinary spreader pipes. These foam pockets constitute a very definite menace to efficient pasteurization because they offer a likely source of bacterial contamination.

TEMPERATURE CONTROL. The temperature control unit is an electric contactor governed in its operation by the thermal reactions of a bulb placed in the milk stream at its point of exit from the heating chamber. This unit governs the control apparatus which modulates the power supply to the electrode chamber so as to hold the milk within ½ degree of any pasteurizing temperature above 160 degrees, for which the control dial may be set. This control of power to the electrode chamber automatically compensates for variations in the temperature of the raw milk supply, room temperature, line voltage, or variation in conductivity of the milk under treatment.

OPERATION. It will be noted that an auxiliary tank, holding approximately 10 gallons, is provided besides the raw milk tank. Both of these tanks are connected with the pump by means of a three-way valve. In starting the plant the auxiliary tank is supplied with a chemical solution which is pumped through the system to completely sterilize the entire unit before the milk run is started. The auxiliary tank is then filled with a weak solution of salt in water of approximately the same electrical conductivity as milk. The dial of the control instrument is set for 180 degrees. The closing of a snap switch now places in operation the automatic temperature control apparatus. The temperature of the salt water gradually builds up, until in about five minutes it has reached 180 degrees, at which point it is held by the automatic controls. This serves to further sterilize the plant and remove all traces of the chemical solution which was pumped through as before noted. After about five minutes the control dial is set for 162 degrees, and the controls will automatically bring the temperature down to this point. As soon as the temperature becomes stabilized,

actual pasteurization is begun by throwing the three-way valve and allowing the milk to follow through directly behind the salt solution. All this has been accomplished by the single operation of two switches, setting the control dial and throwing the three-way valve. The electric pasteurizer requires no further attention until all the milk has been pasteurized. Any emergency that may arise, such as failure of power supply, failure of water flow over the electrodes, or variations in temperature of raw milk, will be automatically taken care of by the controls, and no milk will be permitted to pass into the holding chamber that is not up to proper pasteurizing temperature. If, for any reason, the temperature of the milk from the electrode chamber is not up to 160 degrees, the pump will automatically and immediately shut down, and the milk will be returned by gravity to the heating chamber for further treatment. As soon as it has been returned, the pump will again start, and a test will be made on the milk. If it has attained the proper temperature, the plant will continue in operation; if not, the milk will return for further treatment. This operation will continue until the temperature is correct, at which time normal operation will be resumed. If the flow of cooling water over the outside of the electrodes fails, which is liable to cause the milk to burn onto the electrodes, the power supply will be automatically cut off, and the plant will shut down. As soon as this water flow is restored the plant will automatically start again. As soon as the supply of raw milk drops below a predetermined level, an alarm sounds notifying the operator that he must either refill his raw milk tank or prepare to shut down the plant.

To synchronize the flow of pasteurized milk with the bottling machine, a control valve is provided which may be set approximately 15 per cent above or below the normal speed of delivery.

Thus it will be seen that after the plant is once started, it requires no further attention from the operator, except to keep it supplied with raw milk, or to finally shut it down.

INSTALLATION. The 100-gallon-per-hour unit, which is most acceptable to dealers handling anything under 1200 quarts per day, occupies a floor space about 2½ by 7 feet, and if used with a bottling machine, requires a ceiling height not less than 9 feet. It is easily installed. If the base, power-line entrance, and water and refrigerating pipes are ready, it can be installed and placed in operation within three hours after it is received.

OPERATING COST. The power consumed by the electric pasteurizer is approximately 15 kilowatt-hours, for each 100 gallons of milk pasteurized. No extra labor is required as the plant is entirely automatic, leaving the operator free to devote his entire attention to bottling or any other duties. This low power consumption and economy of labor bring pasteurizing costs down to a point which compares favorably with that of other methods.

TYPE OF LOAD. This installation should make a very desirable load for many of our rural lines. The 100-gallon-per-hour unit uses a constant load of approximately 15 kilowatts. This load is non-inductive and in an average dairy will be in use from two to four hours daily, 365 days in the year, and will usually be used during the early morning hours. In addition to the power used by the pasteurizer, practically all dairies will find it necessary to add refrigerating equipment, if they do not already have it, in order to cool the milk down to proper bottling temperature. The power used by this refrigerating equipment will probably average about as much as that used by the pasteurizer, especially if the dairy does not have an ample supply of cold water.

To the dairy industry the electric pasteurizer offers the following outstanding features:

1 Better Milk. The electric pasteurizer makes possible a higher degree of pasteurizing efficiency with a retention of all natural milk characteristics.

2 Economical Operation. The size described above pasteurizes 100 gallons of milk per hour with a total current consumption of 15 kilowatt-hours.

3 Fast, Dependable Operation. The electric pasteurizer makes available the many advantages of high-temperature pasteurization. Raw milk entering the pasteurizer emerges 45 seconds later, pasteurized, cooled, and ready for bottling.

4 Simplicity of Operation. Because it is entirely automatic, any average person is thoroughly capable of operating the electric pasteurizer after only a few hours instruction. No special knowledge or course of instruction is necessary.

5 Flexible Operation. With practically no lost time the electric pasteurizer will handle any number of separate milk batches. This feature makes it ideal for cooperative use and joint ownership.

6 Compact installation. The greatest possible sanitation is assured by the clean, compact, clear-of-the-floor mounting, made possible by the unified construction of the pasteurizer.

7 Rapid, Easy Cleaning. The electric pasteurizer has a minimum of parts to clean. All removable parts are convenient for disassembly and all unremovable parts are readily accessible for thorough cleaning. All sections of pipe are straight, and polished both inside and out.

New Instrument Measures Speed of Air Currents

A NEW TYPE of anemometer, especially designed for measuring slow air movements such as are present in refrigerator cars, has been developed by the Bureaus of Agricultural Engineering and of Plant Industry, U. S. Department of Agriculture. Operation of the instrument depends on the cooling of a heated wire when exposed to air currents.

So far the instrument has been used to measure only horizontal velocities, but engineers believe it can be used to measure velocities of any direction. Use of the anemometer will result, it is expected, in a better knowledge of the requirements for air circulation and of the conditions under which maximum circulation may be obtained in refrigerator cars.

The instrument is small enough to be placed under the floor rack of a car and may be read from the outside without disturbing conditions inside.

Previous to the development of the anemometer, observations of air velocities in cars were confined largely to smoke tests. Puffs of dense smoke were released at certain points in cars and observations were made of how long it took the smoke to travel to other points. The general direction of air movements could be followed and some idea of velocities of currents were obtained in this way. Difficulty of access to many positions in cars and diffusion of the smoke limited the usefulness of this method.

Also in making smoke tests, it is necessary for at least one observer to be in the car. In some cases, the presence of an observer is likely to set up independent convection currents or otherwise distort those being measured, engineers believe.

NEWS

ASAE Technical Division Meetings

FOUR technical divisions of the American Society of Agricultural Engineers are arranging programs to be presented at meetings to be held at the Stevens Hotel, Chicago, during the week beginning Monday, December 2.

The Power and Machinery Division, as usual, is planning a two-day meeting for December 2 and 3, with possibly a joint program with the Soil and Water Conservation Division on the forenoon of December 4. The joint program between the two divisions will feature the subject of terracing equipment development as related to terrace construction practice, as well as the developments up to date in adapting farm machinery for terrace farming.

The program for this meeting is rapidly taking form, and while a definite decision has not been made in all cases on the matter of subjects and speakers, consideration is being given to a number of interesting and timely subjects, including patent procedure, feed processing and feed grinder design, farm tractor fuels, plow and tillage implement steels, developments in spraying to control weeds, engineering phases of pest and insect control, draft of farm implements, performance studies of small grain combines, seed harvesting equipment, and sodding equipment and contour furrowing.

The Soil and Water Conservation Division is tentatively scheduled to hold its meeting December 4 and 5. In addition to the joint program with the Power and Machinery Division already referred to a most interesting and timely program is being arranged for the benefit of engineers engaged in the various soil conservation activities. The program for Wednesday afternoon, December 4, will feature such subjects as the accomplishment of 48 CCC drainage camps, result of rainfall intensity-frequency studies, and engineering problems involved in the rural settlement program in one of the states of the Middle West.

The entire program for Thursday, December 5, will be devoted to a symposium in which progress will be reviewed and many problems discussed in the engineering phases of soil erosion control, and will include such subjects as terrace project planning, erosion control in terraced outlets, control of gully erosion, development of farm ponds as an erosion control measure, and the development of lakes in rural communities for soil and water conservation.

The Structures Division will hold its meeting coincidently with that of the Power and Machinery Division on December 2 and 3. On account of the many new and interesting developments in building construction, applicable to farm construction requirements, it is planned that papers dealing with such developments will be one of the important features of this program.

The Rural Electric Division is scheduling a round table meeting to occupy a period of one day, and this will probably be held on Wednesday, December 4. This program will feature many subjects of immediate interest to the engineers in rural electrification work, and doubtless a great deal of attention will be given to the relation of the activities of the members of this group to the program of the Rural Electrification Administration.

Copies of the programs for these meetings, as well as other information in regard to them, will be furnished on request to the office of the Secretary, American Society of Agricultural Engineers, St. Joseph, Michigan.

Washington News Letter

FROM American Engineering Council—the "Washington Engineering Embassy"—comes the following news items of particular interest to the engineering profession:

In four months, congress will reassemble. In the interval between now and the first of January, 1936, is the task both of industry and of the federal agencies to adjust themselves to the heavy load of legislation. Both Washington and the country are reviewing with soberness the results of emergency legislation passed during the previous sessions of Congress. There are certain to be difficulties in the way of putting some of the legislation into effect.

There continues to be much confusion in Washington, and, in spite of public statements to the contrary, a growing feeling on the part of those responsible for administering the legislation that there is a big difference between having new ideas and putting those new ideas into action.

We have returned from trips both to the South and to the North within the last four or five weeks. It is made evident that the "emergency" needs have passed, and it is realized that what has been made possible through new legislation now has to be put into action and paid for.

Much of the new legislation concerning as it does natural resources, transportation, and construction, directly affects engineers and engineering development. The regulatory legislation covering utility holding companies, motor carriers, the soft coal industry, and "hot oil"; the increased powers of the TVA and AAA, all tend to centralize authority in Washington over industrial practices and procedure.

The legislation dealing with labor, especially that tending to establish the procedure for collective bargaining by labor, as well as the "social security" system of old-age pensions and unemployment reserves, bring new problems to engineers and to industries employing engineers, in so far as the centralization of regulatory legislation in Washington tends to open channels for constructive study of industrial practices and procedures. There will be many opportunities within industry for men trained in engineering to apply the engineering method of analysis.

Probably in the next ten years many new fields of opportunity for engineers will be opened, not in the government, but in private industry, because of the need of more intensive analysis of manufacturing costs, of relation of machinery to reduction of labor costs, and of manufacturing methods. Undoubtedly, also, there will be an increase in the use of power per man.

Perhaps the most important and widespread development in Washington of immediate interest to engineers is the work relief program. Over the past month hundreds of projects have been approved by the Works Progress administration, Public Works Administration, and other federal units. Thousands of additional projects were in the federal hopper on the September 12 deadline set by the President for receipt of applications. In order to spur the program forward toward the winter peak, the federal, state, and local agencies have been instructed to put the projects on contract or force account work by October 22 and to let all necessary contracts not later than December 15.

Under decentralized control, with responsibility largely in the hands of federal personnel in each state, the program invites more than ever the constructive aid of engineering societies and local sections in supplying unbiased advice along technical lines. The fact that services of engineers and contractors may be used on a fee and contract price basis will enable engineers in private practice to enter the program without sacrificing their present business.

Engineering employment under the program may be expected to show a net gain as field activities expand. Some opportunities also may develop under the new administrative staffs required by new legislation including social security, utility holding companies, coal mining, and motor carriers, but the failure of the third deficiency bill in the last hours of Congress may delay the building of these organizations until after Congress meets in January. These and other acts of Congress have broadened the discretionary power of the Administration and the pending interpretations of the new powers are likely to include decisions of engineering importance.

Among the measures on which final action was not reached by Congress are Senator Lewis' Bill to change the name of the Department of the Interior to "Department of Conservation and Works"; the Walsh bill to regulate hours and wages on government contract work, and the Wagner proposal to make it unlawful for persons other than lawyers to make representations before federal agencies. All bills keep the same status into the next session that they attained prior to the recent adjournment.

The PWA loan rate for non-federal work, on the 45 per cent grant and 55 per cent loan basis, was reduced from 4 per cent to 3 per cent on May 24, but later was returned to 4 per cent. Continuation of the old rate is for the purpose of encouraging communities to use private capital in the financing of reemployment construction projects. Among the non-federal projects recently approved, 130 projects totaling more than $40,000,000 will receive the 45 per cent grant while the applicants are using their own credit sources for the remaining 55 per cent.

After a PWA project has been approved, the present regulations permit funds to be made available so that mutually satisfactory fees may be paid for engineering purposes such as preliminary surveys, plans, and specifications.

Highlights of work relief developments over the past month, in addition to the heavy volume of new projects approved under WPA, touch upon many fields of engineering activity. River and harbor and flood control measures are going forward on a large scale under the Corps of Engineers. . . . The Chicago Sanitary District is undertaking the largest sewerage program in the world with new PWA allotments, bringing the total nearly to $60,000,000. . . . The Second Deficiency Act, approved August 12, releases $60,000,000 for public buildings. . . . The Soil Conservation Service has announced a $27,500,000 program in 42 states. . . . Under a $98,830,000 program for balanced land use, the Bureau of Reclamation will undertake additional projects while ten acres of land for every one reclaimed is to be retired from production under the Forest Service and the Resettlement Administration.

Secondary roads will receive not less than $50,000,000 of the $200,000,000 allotted for highways from the $4,880,000,000 fund. . . . The PWA Housing Division has under way 76 projects of the slum clearance, low-rent housing type and has been acquiring new sites. . . . Additional housing plans are being developed by several agencies. . . . A power division under PWA is giving special attention to applications from municipal plants. . . . New surveys by the Bureau of the Census offer engineering opportunities along statistical lines. . . . General collection of data, together with planning work, is continuing under the National Resources Committee and the Water Resources Committee.

* * * *

The soil and foundation survey of New Orleans, being carried on as a federal project under sponsorship of the Louisiana Engineering Society, is reported as making good progress. Local engineers and architects are cooperating by furnishing data in their possession. As noted in our letter of July 15, a staff of engineers, architects, and draftsmen are at work under the supervision of a committee of four prominent engineers. The survey is expected to be of great value in planning construction which is complicated by the variable soil conditions underlying the city. Engineering societies wishing to have similar work done in their areas may consult local and state engineers of the Works Progress Administration.

"Rainfall Intensity-Frequency Data"

THE intensity and frequency of rainstorms in a locality is of great importance in determining the proper design for various engineering works. In recognition of the need for accurate records of the sort, the Bureau of Agricultural Engineering, U. S. Department of Agriculture, has made them available in a new publication that is of special interest to those building farm terraces, drainage works, highway and railway culverts, city storm sewers, and other works designed to care for storm runoff. It is Miscellaneous Publication No. 204, entitled "Rainfall Intensity-Frequency Data."

David L. Yarnell, senior drainage engineer of the Bureau, has correlated and compiled concise and comprehensive information on rainfall intensities, covering periods of 10 to 50 years, at each of the 206 Weather Bureau rainfall stations equipped with automatic rain gauges. He believes these records are sufficient for predicting with reasonable accuracy the average period of recurrence of intense precipitations in any part of the country. The short-period records cover a total of 28,077 rainstorms and extend through 1933.

From records of excessive short-time precipitations at the Weather Bureau stations, Mr. Yarnell has prepared tables showing for each station the short-interval record of the most intense storm and the maximum short-period precipitations that have occurred. He has prepared charts showing the maximum precipitations in periods of 5 minutes to 2 hours that may be expected to occur with average frequencies of 2 to 100 years. From the same records and from those of 24-hour precipitations, he has prepared similar charts showing the maximum 4-hour to 24-hour precipitations of 5-year to 100-year frequencies. Other charts show the number of excessive rainstorms by months in a period of 30 years.

The analyses made by Yarnell of rainfall records furnish a basis for computing required capacities for drainage systems, storm sewers, culverts, etc., to safely care for excessive precipitations.

Because single-station records seldom, if ever, give a correct picture of the normal rainfall experiences in any particular area, the charts are based upon the weighted rainfall experience of all Weather Bureau stations, and are more dependable for design of structures than the records of any individual station.

Certain localities have been interested in records of intensity and frequency of rainfall of short durations for their own vicinities, but this is the first attempt on the part of any individual or organization to coordinate this valuable information for the entire country.

Miscellaneous Publication 204 is for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents a copy.

Personals

U. S. Allison was recently appointed chief agricultural engineer on the Plum Creek Project of the U. S. Soil Conservation Service, near Lockhart, Tex. Prior to this appointment he was on the agricultural engineering staff of the A. & M. College of Texas.

Eugene C. Buie has resigned as associate professor of agricultural engineering at Texas Technological College to become associated with the U. S. Soil Conservation Service.

I. W. Dickerson is now on the agricultural engineering staff at Iowa State College, Ames.

W. C. Gillham was recently appointed assistant agricultural engineer of the Tennessee Valley Authority, to specialize in the design of small-scale farm machinery for Tennessee Valley farms.

Dan Scoates, head of the agricultural engineering department, A. & M. College of Texas, is on leave for a year, and during that time will serve as regional chief, project development section, rural resettlement division, Resettlement Administration, with headquarters at Stillwater, Okla.

Ivan D. Wood, in charge of agricultural engineering extension, University of Nebraska, was recently appointed chief of engineering for The Plains Shelterbelt Project, embracing the states of North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas, with headquarters at Lincoln, Nebraska. In addition to himself, his staff includes an associate engineer, six assistant engineers, and twelve engineering aides. Aside from surveys for land acquisition there are many problems dealing with erosion control and water conservation. He still retains his connection with the University.

* * * *

(EDITOR'S NOTE: ASAE members are urged to send in appropriate news of themselves and other members for this column.)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the September issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

E. E. Austin, technical foreman (junior), Soil Conservation Service, U. S. Department of Agriculture. (Mail) CCC Camp SCS-T-23, Marshall, Tex.

Paul M. Browning, technical foreman, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 703, Mt. Pleasant, Tex.

Thomas J. Flippin, Jr., resettlement manager, Resettlement Administration. (Mail) 417 Miner Bldg., Eugene, Ore.

Arlee C. Hanson, technical foreman (agriculture), Soil Conservation Service, U. S. Department of Agriculture. (Mail) Carrollton, Ill.

Ivan G. Morrison, assistant, agricultural engineering department, Cornell University, Ithaca, N. Y. (Mail) Dairy Building.

J. A. Nichols, junior engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 446, Lockhart, Tex.

Mathew Novak, assistant in engineering department, Avery Power Machinery Company, Peoria, Ill.

Albert T. Petersen, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 1346 Say Road, Santa Paula, Calif.

Harold E. Pinches, assistant professor of agricultural engineering, Connecticut State College, Storrs, Conn.

Pinckney Bryan Price, associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 165, Dublin, Tex.

H. J. Raths, assistant state technician (ECW), Soil Conservation Service, U. S. Department of Agriculture. (Mail) 10 Beechwood Place, New Brunswick, N. J.

J. Emery Veatch, senior engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 215 South 2nd St., Maquoketa, Iowa.

TRANSFER OF GRADE

Harold W. LeMert, chief agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Gwynn Bldg., Shenandoah, Iowa. (Junior to Member)

George A. Rietz, in charge of rural electrification section, General Electric Co., Schenectady, N. Y. (Junior to Member)

J. P. Schaenzer, agricultural and irrigation engineer, National Power Survey, Federal Power Commission, Washington, D. C. (Associate Member to Member)

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE ARKANSAS STATION, *D. G. Carter, J. B. Woods,* and *R. M. Smith.* Arkansas Sta. Bul. 312 (1934), pp. 9, 10. The progress results are briefly presented of investigations on preservative treatments for fence post wood, water cooling of milk, farm buildings for Arkansas, farmhouse planning, and effect of poultry housing factors on egg production.

THE FUNCTIONS OF THE VIRGINIA ENGINEERING EXPERIMENT STATION, *E. B. Norris,* Va. Engin. Expt. Sta. Bul. 19 (1934), pp. 32, figs. 15. This is a brief prospectus which discusses the general features of industrial research and points out specifically the functions of the engineering experiment station at Virginia Polytechnic Institute. Lists of active research projects and of technical and extension bulletins are included.

SOIL EROSION AND FARM HOUSING INVESTIGATIONS. U. S. Dept. Agr., Sec. Agr. Rpt., 1934, pp. 101, 102, 103-105. It is briefly reported that tests at the erosion experiment farms continue to demonstrate that terracing is the most effective single means of controlling soil erosion on cultivated land. It is particularly effective on land devoted to such crops as corn and cotton. Supplementing the terraces with contour plowing and the use of soil-saving and soil-building crops gives the best results.

A brief account also is given of the farm housing survey conducted in cooperation with the agricultural colleges and experiment stations in 46 states. In this survey more than 600,000 farm homes in 352 counties were studied. The survey indicated that probably 50 per cent of our rural homes are in good structural condition. On the other hand, some 15 per cent of the houses need new foundations, between 15 and 20 per cent need new roofs, from 10 to 15 per cent need new floors, and about 10 per cent need extensive repairs or replacement of exterior walls. Between the extremes of houses in good condition and those needing complete replacement of some part or all of the house is a large group needing extensive repairs of some kind, including refinishing inside and painting outside.

FOURTH PROGRESS REPORT: PRIMING-COAT REDUCTIONS FOR PAINTING NEW WOOD SURFACES, *F. L. Browne.* U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1934, pp. 13. This is a report of a project conducted by the USDA Forest Service Forest Products Laboratory in cooperation with several private agencies. The object of the study is to discover the optimum priming-coat reduction in applying common house paints to softwoods and to determine whether the priming coat should be reduced differently according to the nature of the softwood painted.

Four woods and three paints were used in the experiments on priming-coat reduction. The woods were Norway pine, northern white pine, western red cedar, and redwood. The paints were white linseed oil house paints that differed only in the nature of the pigments. In one the pigment was entirely basic carbonate white lead; in the second the pigment contained 60 per cent by weight basic carbonate white lead, 30 per cent lead-free zinc oxide, and 10 per cent magnesium silicate; and the pigment of the third contained 60 per cent titanox B, 30 per cent lead-free zinc oxide, and 10 per cent magnesium silicate.

In the studies of the effect of priming-coat reduction it seems that the ratio of oil to turpentine is more significant, at least within the range of desirable reductions, than is the pigment volume. Apparently a good primer should have at least 2½ times as much linseed oil as turpentine, and it is questionable whether there need be any turpentine in the primer at all. The pigment volume in a good primer for 3-coat painting presumably may be anywhere in the range of 20 to 30 per cent, but for 2-coat painting practical considerations require that the pigment volume be in the upper portion of this range. The data suggest the same optimum priming-coat reduction for all woods, namely, reduction with linseed oil and little or no turpentine.

On cedar, white pine, and Norway pine the average durability of the three paints was inversely proportional to the average density of the boards of those species. The durability on redwood, however, was about as great as it was on red cedar, although the density of the boards was nearly the same as the density of the white pine. On redwood and red cedar these paints were proving practically equal in durability, but on white pine and Norway pine the titanox and zinc paint had disintegrated earlier than the other two paints. As a result, there was a greater variation in durability on different woods with the titanox and zinc paint than with either of the other two paints.

With the white lead paint and the titanox and zinc paint the best 2-coat job (priming-coat reduction 2-1) proved equal or superior in durability on the whole to the best 3-coat job (with white primer) applied on the same boards. With the lead and zinc paint the best 2-coat job was slightly inferior to the best 3-coat job on the same boards except on red cedar, where it was better. It is evident that 2-coat painting when done in the manner followed in these experiments is thoroughly practicable and gives coatings that closely approach good 3-coat work in durability and prove distinctly better than poor 3-coat work.

The best results were obtained with aluminum priming paint followed by two coats of white paint. On all woods except white pine the coatings of all three paints over aluminum primer were still rated fair minus or better in integrity at the last inspection, and in all cases except that of lead and zinc paint on white pine the coating over aluminum primer was rated as high or higher in integrity than the best coating over a white primer on the same boards.

SPECIAL PRIMING PAINTS FOR WOOD, *F. L. Browne.* U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1934, pp. 15, pls. 6. Twenty special priming paints were subjected to practical exposure tests at Madison, Wis., Fargo, N. Dak., Fresno, Calif., Sayville, N. Y., and Washington, D. C. The special priming paints were compared directly with conventional priming with white finishing paint applied on neighboring areas of the same boards. Two white finishing paints were used, pure white lead paint and a lead and zinc paint. Ten of the special primers proved beneficial in the sense that they retarded disintegration of coatings over the bands of summerwood in southern pine and Douglas fir and made the durability of the coatings on those woods more nearly equal to that on redwood and northern white pine. The best of the special primers tested were those containing "leafing" pigments, aluminum powder, or flake graphite, in tung-oil spar varnish.

EROSION CONTROL INVESTIGATIONS AT THE TENNESSEE STATION. Tennessee Sta. Rpt. 1933, p. 13. The progress results of studies in erosion control are briefly presented which emphasize the importance of terracing for the protection of land planted to row crops and the protective action of pasture grasses.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEW HAVEN STATION. Connecticut [New Haven] Sta. Bul. 366 (1935), pp. 83, 84. The progress results are briefly presented of investigations on the durability of treated posts and on the treatment of tobacco tent poles.

ARTESION WATER IN SOMERVELL COUNTY, TEXAS, *A. G. Fiedler.* U. S. Geol. Survey, Water-Supply Paper 660 (1934), pp. IV + 86, pls. 7, figs. 5. This report, prepared in cooperation with the Texas State Board of Water Engineers and State Department of Health deals with the artesian water supplies of an area in the Grand Prairie region of north central Texas, which are used chiefly for domestic purposes and for watering stock.

The draft from the artesian reservoir in Somervell County during the summer is estimated at about 1,000,000 gal a day, distributed as follows: Domestic use, 150,000 gal; stock use, 60,000 gal; recreation pools, 250,000 gal; irrigation, 180,000 gal; and waste, not including underground leakage, 360,000 gal. In winter the daily draft is probably about 370,000 gal less than in summer.

The quality of the water obtained from a depth of more than 50 ft is satisfactory for domestic use, but the shallow ground water in the surficial deposits is at least in part polluted and hence unsuitable for drinking and cooking. Shallow, insufficiently cased artesian wells and unplugged abandoned wells offer opportunity for the entrance of this polluted water into the artesian supply. Any further lowering of the artesian head will increase the danger of such pollution.

A program for conservation of this artesian water supply is recommended. *(Continued on page 422)*

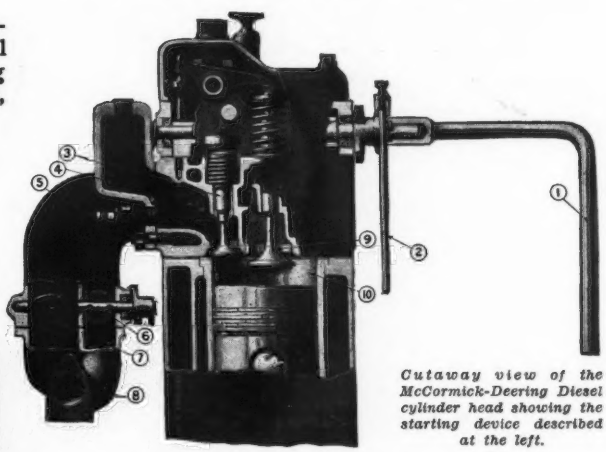
Simplified Starting Feature is Diesel Engineering Achievement

The McCormick-Deering Diesel 40 engine offers the exclusive advantage of starting as a gasoline engine and converting itself automatically to Diesel operation. This starting arrangement does away with the usual costly and cumbersome devices for starting, such as auxiliary engines, pumps, electric starters with heavy-duty batteries, etc. It enables the operator to crank the engine as readily as a conventional gasoline engine of corresponding size.

Setting a single control (1) (below at the right) engages the starting mechanism. This opens a valve (3) in the cylinder head, adding an auxiliary combustion chamber (4) for each cylinder, which reduces the compression pressure. A high-tension magneto is automatically engaged and furnishes a reliable spark to the plugs (5) mounted in the auxiliary chambers. The control also opens the butterfly valve (6) connecting the gasoline carburetor. This changes the engine to gasoline operation, ready for starting as a conventional gasoline engine.

When the engine has made a predetermined number of revolutions, it shifts automatically to Diesel operation. The auxiliary valves (3) close, isolating the auxiliary combustion chambers and spark plugs, restoring the Diesel compression pressure. The magneto and carburetor are automatically disengaged. The Diesel fuel injection system starts to function and the engine continues to operate with an uninterrupted flow of power.

This simple operation changes the McCormick-Deering Diesel into a conventional gasoline engine for starting.



Cutaway view of the McCormick-Deering Diesel cylinder head showing the starting device described at the left.

This view shows the Diesel TracTrac-Tor. The Diesel 40 engine is also available in a wheel-type tractor — the McCormick-Deering WD-40.

McCORMICK-DEERING TD-40 TRACTRACTOR

Here is a crawler tractor that offers the utmost in Diesel performance and economy. It operates on low-priced fuel without magneto, spark plugs, or carburetor, yet it starts under all weather conditions as easily as a gasoline tractor of equal capacity. Combined with the unique feature of easy starting are the outstanding features of unit construction and accessibility. The McCormick-Deering is the most accessible crawler tractor built. Complete information will be forwarded on request.

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Agricultural Engineering Digest

(Continued from page 414)

WATER AND SEWAGE RESEARCH. New Jersey Stas. Rpt. 1934, pp. 92-97. The progress results are presented of studies on sludge dewatering, activated sludge, effect of chlorine in sewage treatment, analyses of sewage and sludges, corrosion of aluminum ware by well water, bacteriology of water and sewage, and institutional well waters, and of studies and surveys conducted under Civil Works Administration projects.

IRRIGATION INVESTIGATIONS AT THE NEW MEXICO STATION. New Mexico Sta. Rpt. 1934, pp. 61-68, figs. 2. The progress results are briefly presented of investigations on duty of water, rate and cause of rise of ground water in the Mesilla Valley, irrigation of potatoes, water requirements and economical use of water for cotton and other crops, effect of different irrigation treatments on maturity, lint, and yield factors of Acala cotton and labor requirements for production, and effect of fertilizers and frequency of irrigation on the yield and keeping and marketing qualities of the Early Grano onion.

ELECTRIC BROODERS ON INDIANA FARMS, *T. E. Hienton.* Indiana Sta. Circ. 187, rev. (1934), pp. 4, figs. 3. This is a revision of this circular.

BEHAVIOR OF HOUSE PAINTS ON DIFFERENT WOODS, *F. L. Browne.* U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1934, pp. 25, pls. 9. This mimeographed paper reports data on the effect of kind of wood painted on the serviceability of house paints obtained from observation of practices and experience with houses in service and experimentation by means of test fences.

In conclusion, a classification in tabular form is presented of native woods according to their desirability for exterior house painting by conventional methods.

AGRICULTURAL ENGINEERING [INVESTIGATIONS AT THE SOUTH DAKOTA STATION], *R. L. Patty.* South Dakota Sta. Rpt. 1934, pp. 14-17. The progress results are briefly presented of experiments on rammed earth for farm building walls, corn harvesting machinery, field machinery hitches for tractor and large horse teams, the effect of protective coverings upon the length of service of steel fence posts, and rammed earth walls in poultry house construction.

WATER CONTROL INVESTIGATIONS [AT THE FLORIDA STATION], *R. V. Allison* and *B. S. Clayton.* Florida Sta. Rpt. 1934, pp. 94, 95, fig. 1. The progress results are briefly reported of investigations of water level in soils of the Everglades.

LIST OF PUBLICATIONS ON GLUE AND PLYWOOD. U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1934, pp. 9. A number of publications from governmental and private sources are included in this list.

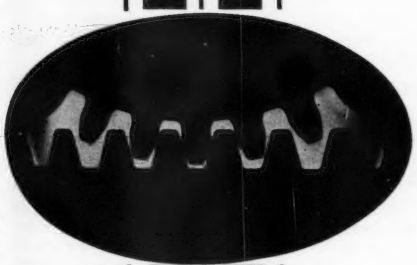
LIST OF PUBLICATIONS ON THE MECHANICAL PROPERTIES OF WOOD AND WOOD PRODUCTS. U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1933, pp. 25. Publications listed relate to factors affecting strength, joints and fastenings, methods of determining properties, steam bending, and structural timbers.

LIST OF PUBLICATIONS [ON] CHEMISTRY OF WOOD AND DERIVED PRODUCTS. U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1934, pp. 32. This mimeographed list includes publications relating to the chemical composition of wood, chemical and physical properties of wood, chemical industries using wood, particularly for alcohol and other products manufactured, and the chemistry of wood preservatives.

LIST OF PUBLICATIONS ON WOOD PRESERVATION. U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1934, pp. 27. This mimeographed list includes publications relating to crossties, decay, durability, effect of treatment on strength, fireproofing, poles and posts, preservatives such as coal-tar creosote, sodium fluoride, and zinc chloride, wood preservation, termites, shingles, and storage.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE INDIANA STATION. Indiana Sta. Rpt. 1934, pp. 8-16, figs. 8. The progress results are briefly presented of investigations on mechanical corn production, cornstalk coverage, plow adjustment, mechanical corn-picker loss, low corn cutting, low-pressure pneumatic tires, use of electric illumination for forcing crops in commercial greenhouses, electric soil heating, relation of electricity to agriculture, operating hay chopping machine with electric power, codling moth control with electric traps, power consumption in stationary and portable methods of spraying, precooling of fresh fruits in refrigerator cars, electric brooding, electric dairy sterilizers, combined harvester-thresher, poultry housing, field ensilage harvester, soil erosion control, and hay and grain drying. *(Continued on page 424)*

For results of "Caterpillar" Precision, see this Diesel Forty plowing and double-discing in Indiana on 1.06 gallons of 7c fuel per acre. "Caterpillar" Diesels are delivering similar savings to thousands of owners, in America and 58 other countries!



This silhouette view suggests how an image of Diesel governing parts is projected with 100 times magnification. Ingenious comparison then enables trained eyes to detect even the slightest variation from specifications.

How 0.0001" Back-lash Affects A 7.4c per Acre Fuel Cost!

For smooth, efficient Diesel engine performance at any given load, the right quantity and an exactly equal quantity of fuel must be injected into each cylinder. At the "Caterpillar" Diesel's full load, a single fuel pump stroke injects approximately 0.0099 cubic inches of fuel and 0.0025 cubic inches at idling.

The "Caterpillar" Diesel's alert governor moves the governing racks of all fuel pumps simultaneously—each movement must turn the individual gear on every fuel pump the identical fraction of a revolution, to assure perfect fuel metering. That's why the governing racks and gears of "Caterpillar" Diesel fuel pumps have 0.0001" back-lash—ample for free action, yet so close as to assure instant and uniform response.

Interesting examples of "Caterpillar" Precision methods are shown in the booklet, "Turning Precision Into Performance." Your copy will be mailed on request. CATERPILLAR TRACTOR CO., Peoria, Illinois.

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INVESTIGATION WITH PNEUMATIC RUBBER TIRES ON BINDER DRIVEWHEELS [trans. title]. *G. Preuschen* and *H. J. von Zieten.* Technik Landw., 15 (1934), no. 10, pp. 228-230, figs. 6. Studies conducted at the technical laboratory at Landsberg in Germany are briefly reported in which both horse and tractor binders were used. It was found that the use of rubber tires offered no difficulties either on the tractor-drawn or horse-drawn binder. By the selection of the correct tire size it was possible to lower the rolling resistance of the drivewheels by 50 per cent. In that connection the depth of the tire was less important than the width, which should vary between 200 and 250 mm (7.8 to 9.7 in), according to the weight of the binder. It was possible to avoid excessive slippage by lowering the air pressure within the tires. The draft data indicate a small but apparently not very significant decrease in draft due to the rubber tires.

STATISTICS OF FARM MACHINERY [trans. title], *W. Stauss.* Technik Landw., 15 (1934), no. 12, pp. 271-273, figs. 2. Statistical data on the number and acreage distribution of seeding and mowing machines in the different provinces of Germany during the years 1907, 1925, and 1933 are presented and discussed.

DATA FROM THE PLOWSHARE CONTROL ACTIVITIES OF THE GERMAN AGRICULTURAL SOCIETY [trans. title], *W. Kloth, G. Schmidt,* and *H. Lischke.* Technik Landw., 15 (1934), no. 12, pp. 273-280, figs. 32. Data on the chemical composition, hardness, heat-treatment, and other metallurgical characteristics of plowshares manufactured by German implement manufacturers during the years 1931 to 1934, inclusive, are presented and discussed.

Special attention is devoted to the relation between hardness and other qualities of durability with metallurgical composition with reference to such factors as carbon, silicon, manganese, phosphorus, and sulfur contents.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS WANTED

AGRICULTURAL ENGINEER, technical graduate with additional M. E. training, 3 years of experience, desires position in testing and development work for machinery manufacturer, or research and teaching farm power and machinery and land reclamation in state university. Now employed. PW-263

AGRICULTURAL IMPLEMENT SALESMAN, college trained, age 32, married, born and reared on midwestern farm, 7 years experience operating territories in the New England states for a large implement manufacturer, desires similar position in Middle West with large full line implement manufacturer or jobber. Now employed. PW-264

AGRICULTURAL ENGINEER, college trained, with three years' experience in farming, landscape engineering, and farm surveying, desires position in land reclamation, soil conservation, or machinery testing and development, preferably in southeastern states. Age. 25. Married. Now employed. PW-265

POSITIONS OPEN

EXTENSION AGRICULTURAL ENGINEER wanted in one of the states of the Southwest. Duties will include attention to problems of soil erosion, farm and community buildings, and some housing and home equipment. A man around 30 to 35 years of age preferred, with degree in agricultural engineering, some experience in vocational teaching, extension, college, or applied commercial work, who has good judgment and can meet and work with people well. Salary will depend on qualifications—probably about $3000.00, with chance for permanent work. PO-107

EXTENSION AGRICULTURAL ENGINEER wanted to head up agricultural engineering extension in one of the leading agricultural states of the Middle West. Salary from $2000 to $3200 depending on experience and ability. Plenty of time will be taken to secure the services of the best man possible for the position. PO-108